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ILLINOIS TECHNOGRAPH

APRIL, 1955

25¢

John F. Holt, class of '47

speaks from experience when he says . . .

"Expanding research and product development at U. S. Steel mean more opportunities for qualified engineers"

SINCE 1952, John F. Holt has been Assistant Superintendent of the Coke and Coal Chemicals Department at United States Steel's new Fairless Works in Morrisville, Pa. He started working at U.S. Steel—as a trainee—in 1947. That's a lot of progress in just five years. For in his present position, John is responsible for both the quality and the quantity of all coal chemicals produced at the Fairless Works – about 3,500,000 gallons of light oils per year. 190 hourly employees and 25 supervisory personnel report to him.

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If *you* are interested in a challenging and rewarding career with United States Steel and feel that you can qualify, you can obtain further information from your college placement director. Or we will gladly send you our informative booklet, "Paths of Opportunity," upon request. Just write to United States Steel Corporation, Personnel Division, Room 1622, 525 William Penn Place, Pittsburgh 30, Pa.

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All of you, no doubt, ask about security when you seek a job. How much you want to pay for security is a matter for your own choice. It is wise to consider the fact that you have already paid for a great amount of security. Your education and good sense are your greatest security. This is something you can't buy, but you already have it. Nothing pays off in security like competent work and the ability to get along with people.

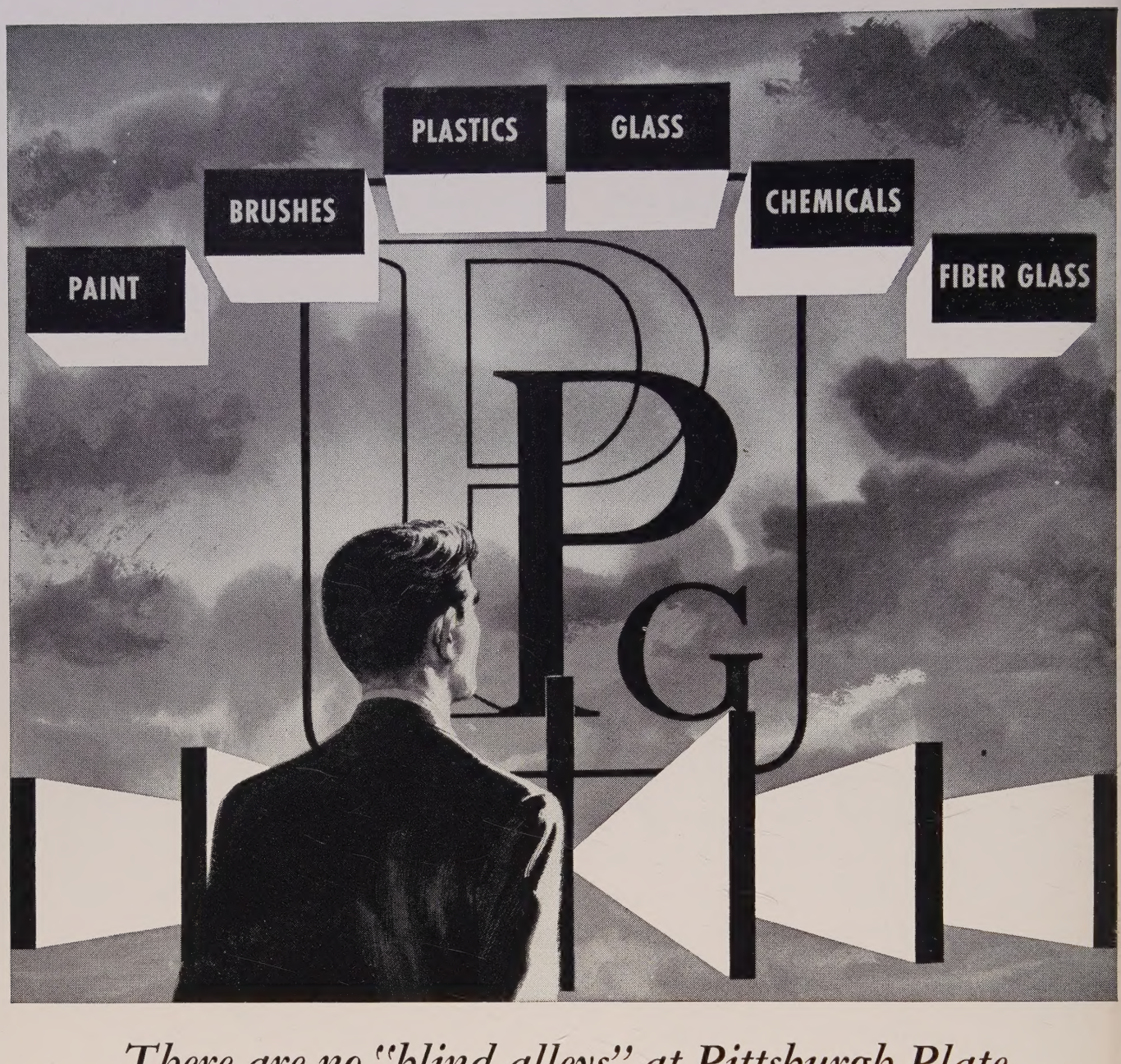
With an engineer's education, the price of security is very cheap. Employers are more anxious to keep you than you are to work for them. Employers recognize the high cost of training new personnel.

Security can be costly. Civil service and armed services offer a lot of security, but it cuts down take home pay. Security has to be costly because it is a guarantee that you won't be fired if you don't make the grade. Therefore your talents are underestimated and you are paid accordingly. If you have confidence in your engineering ability, you need less security than one who has less confidence in himself.

The chances for advances are worth much more than security. Advancement is a company policy and should not reflect starting salary. Since the company loses nothing, they don't take it out on your pay. The thing to be sure of is that the company has a policy of promotion from within its ranks. When a company has this policy, they are more careful to watch for those who are qualified for advancement. In this company you have a lot better chance of being recognized than in one which hires an outsider to fill a position.

In all you do, your efforts will be recognized and they will tell whether you have confidence in yourself, or loaf or do careless work. Your greatest asset is your initiative. Use it to your fullest extent.

D. F. K.



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THE ILLINOIS TECHNOGRAPH

volume 70 **number 7**

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our cover

The Pontiac Stratostreak V-8 engine is a typical example of the great strides that have been made in the field of automotive engine design. This 180 horsepower package is more than just an outstanding engineering achievement. From hydraulic valve lifters to quad- galley lubrication; from ball-pivot rocker arms to reverse flow gusher valve cooling — all represent man's effort to better himself. (Color cover-plates courtesy of Pontiac Motors Division, General Motors Corporation.)

our frontispiece

The 1955 Jaguar convertible was shown at the Champaign-Urbana Optimist Club sports car show. This XK-140-M is slightly modified in the engine compartment and has four seats.

More than Just Transportation

by Don F. Kesler, E. E. '56

The main difference between hot rods and sports cars is the method of attaining the common goal. The goal is performance and safety.

The approach of the hot rodder is to take big American cars and do as much for them as possible. Great improvements are made on the existing cars, however, the limiting factor is the starting point of the basic car.

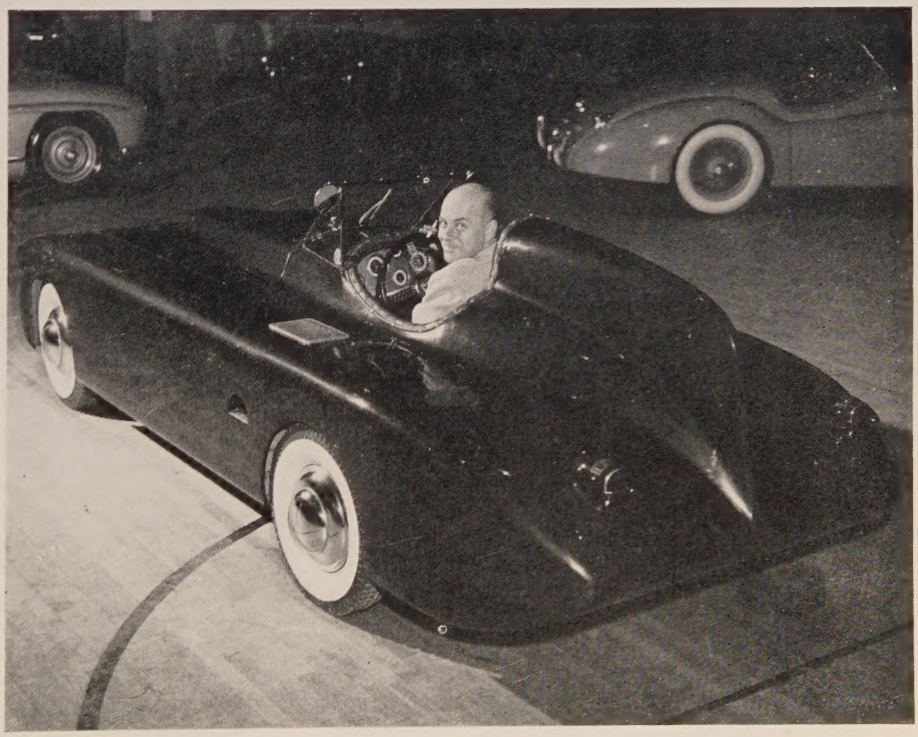
The sports car fan attacks the problem from the foundation. The basic car is designed with competition and road work in mind. Since a car is of little use unless it can be driven on the street, all street equipment is necessary. It must have complete headlights, tail lights and a horn. Also it must be equipped with a spare tire and fenders. If the fenders are the cycle type, they must cover at least an arc of 120 degrees along the wheel.

Sports cars must be built to be driven on service station gasoline, since this is what is allowed in sponsored sports car races. The only gasoline that may be used is furnished by the officials, so that rules out all alcohol and nitro mixtures. It also keeps sports car racing from getting out of reach of many would be enthusiasts. Any carburetor, cam, or manifold modifications are legal in all except strictly stock classes.

The job of a sports car in competition is to get the driver from one point to another point in the shortest time for a given engine size. To do this job, it is essential that the car corners well and accelerates well.

There are many factors concerning cornering. A firm suspension is one of the first. It takes a firm suspension to counteract the roll caused by the moment of the center of gravity acting about the roll center. Obviously there are two ways to cut down roll—lower the center of gravity or raise the roll center. So the job is to do both. Lowering the center of gravity is merely getting the weight as low as possible, however there are more variables in raising the roll center. The variation in roll center comes from different types of suspension. In general, the SFA (solid front axle) has a higher roll center than any IFS (independent front suspension). The roll center on the SFA is at the spring perch. The roll center on the IFS ranges from below the ground to a few inches above the ground depending on the individual design. One exception to this is the Allard front suspension, which has a high roll center. This is essentially a solid axle that has been cut in the middle and pivoted at both ends at the center of the frame. It also has radius rods. Even though it has a high roll center, very little can be said for the Allard handling qualities.

The Porsche has a very good suspension that is different. It has four wheel independent suspension with about nine inches wheel travel. The employment of trailing link suspension makes possible the soft ride with horizontal stability. Torsion bars parallel to the axle produce the spring action. The wheels follow the torsion bars like swivel castors without the swivel. The action of the wheel is vertical with a little action forward and backward due to the arc about the radius of the offset between the torsion bar and the axle. This takes out most of the roll tendencies of the conventional "A" arms that are used on most American cars. It is impossible to imagine such a soft ride, yet such excellent cornering qualities. There is no thrust on the steering wheel over rough roads at speeds of over 110 miles an hour. The Volkswagen, which sells for under nine hundred dollars in Germany, or about sixteen hundred dollars here, also uses this type of suspension. An American manufacturer cannot imagine a car with four wheel independent sus-



Benjamin F. Harris III's custom built special. The car utilizes two four cylinder Austin engines mounted on a single crankshaft in the form of a V-8.

pension being produced for under nine hundred dollars. It is a fact that the Volkswagen ranks fourth in car sales in the world. This puts it just after Ford, Chevrolet, and Buick.

Roadholding as well as riding qualities come from a high sprung to unsprung weight ratio. That is done by having the lowest possible weight of the axles, wheels, and springs. Torsion bar suspension removes the weight of the spring from the unsprung weight. Independent suspension removes the weight of the axles and more important, the differential and driveshaft. A low unsprung weight reduces the inertia the body must stop when the wheels go over a bump. Thus a reduction in unsprung weight reduces bumps in direct proportion to the decrease in unsprung weight. This improvement in ride in no way hampers road holding qualities. In fact it improves them by reducing the amount of time the wheel is off the ground after the car goes over a bump. More torque is transmitted to the road and the cornering is improved.

The ability to go into a controlled drift is a very important factor in cornering. Drifting is a mild slide by all four wheels that enables power to be applied and cut down the amount of body roll. The amount of drift is very easily controlled by the amount of power applied to the rear wheels. The size of tires, tire pressure, spring rate, available torque, and type of suspension are all important factors in controlled drift. The inherent ability comes from the type of suspension and spring rate, but this can be varied to a certain extent by the area of contact of the tires and tire pressure. The center of gravity is highly important in the amount of drift. If the center of gravity is high it will take a large amount of torque to make a given car drift. With a lower center of gravity, the car will drift with a lesser amount of torque or will slide more for the same amount of torque. Ordinarily, there is little concern in getting the center of gravity too low. This is unusual, but can easily be done with small cars with a solid axle.

It is generally recognized that the rear spring rate should be about sixty per cent of the front spring rate. This means the rear springs are softer and allow most of the roll to be counteracted by the front wheels. Thus there is less rear wheel pickup, and less wheel spin on the corners. In turn, there is more torque, and better cornering. This also helps the ride since the driver is sitting very close to the rear wheels in a sports car. The leverage of the front wheels on the driver is small compared to that of the rear wheels. The shock transmitted to the driver is proportional to the leverage and the stiffness of the springs. Therefore the springs may be much stiffer in front than the rear and still not make the ride appreciably worse.

Acceleration is almost completely dependent upon weight, horsepower, and gear ratio. Aside from the drag, acceleration is proportional to torque divided by the weight. A cut in weight reflects an equal per cent gain in acceleration. A good, or fat, horsepower curve is just as important as high peak horsepower. Horsepower is in the lower RPM ranges is used much more than in the peak range.

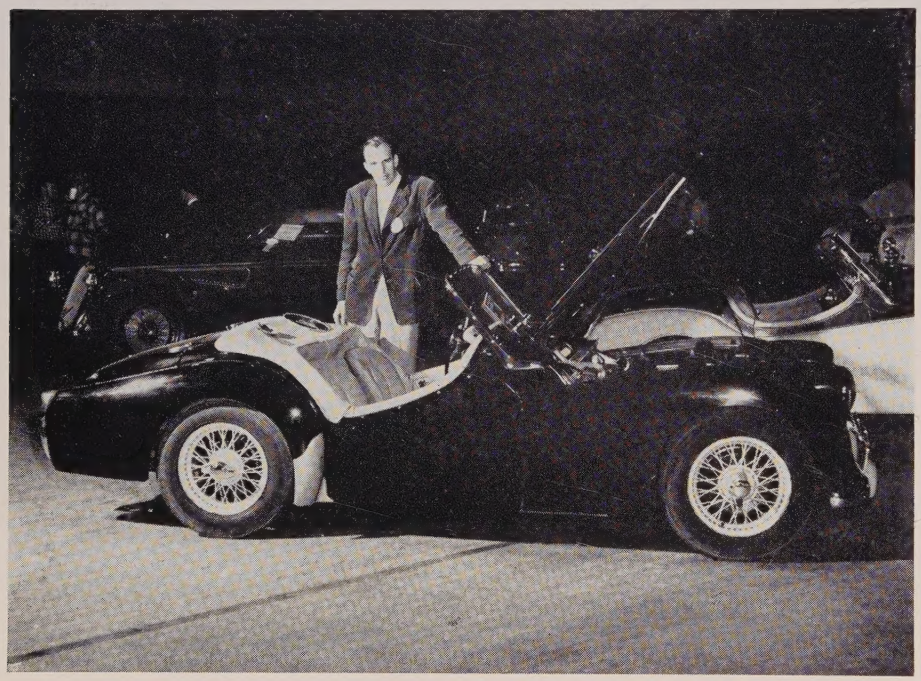
Since sports car competition is based on engine size, boring and stroking should not be carried out so as to put you in the bottom of the next highest displacement class. The RPM of peak horsepower is not of importance if no more horsepower can be attained at more RPM's. Where a high RPM engine is used, a lower gear ratio is used so the final torque is only dependent on horsepower and not on engine speed.

American cars violate almost all rules of good performance. The cars are heavy, have poor aerodynamics, are too large to handle good, and have poor weight distribution. The steering ratio is too high, the tires are low pressure, the center of gravity is high, and the roll center is low. Most of the transmissions are automatic, which cause poor control of gearing and power curves. The one thing that can be said for American cars is the high horsepower engines, however, the displacement is so large that they cannot be called high output engined by any stretch of the imagination.

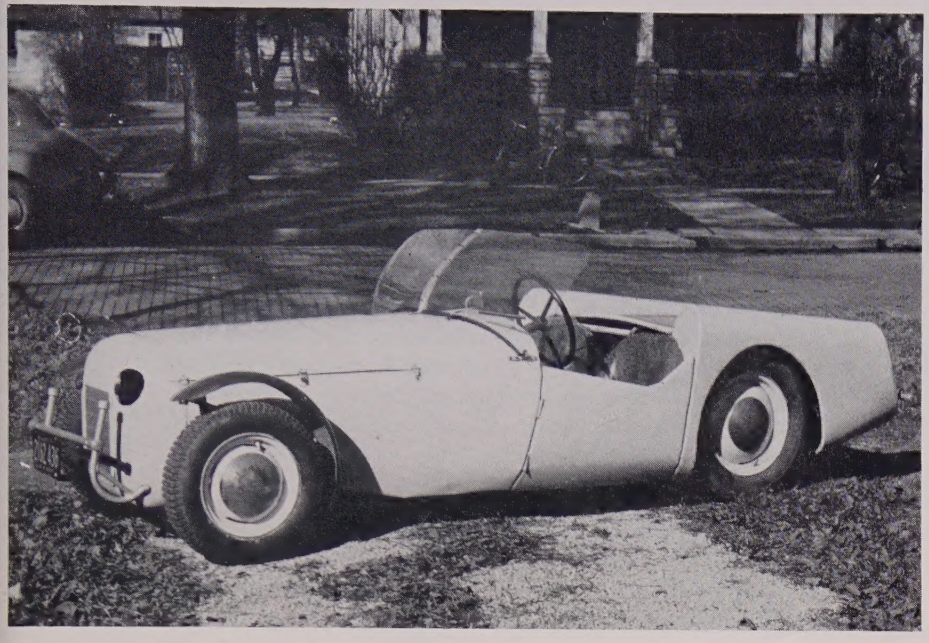
The hot rodders are to be congratulated for what they have done for their cars, however they must be compared to a Ferrari of comparable engine size. The largest Ferrari is under 300 cubic inches. Even with the difference, the Ferrari went 180 miles an hour in the Mexican road race. The Monza and Mondial Ferrari (183 cubic) can top the 4.9 on short courses. The hot rods cannot come close to these cars of only a half their engine size.

A sports car is fun to drive because it is responsive to your command. The easy steering comes from good weight distribution and light weight. Fast steering means quick response, because the driver does not have to turn the wheel so far. Brakes that never fade are essential on a competition car. Light weight, large lining area, and large diameter brakes reduce the strain in long races. Disc or spot brakes are very effective in combatting fade. Aluminum alloy with steel liners make brakes run cooler than cast iron brake drums. Braking from 150 to 30 miles per hour takes the toll of cars with good brakes. The Jaguar has three spots per wheel spot brakes on its competition models. The patent is licensed from a U. S. company. Why can't U. S. car manufacturers make use of these superior brakes. These are but a few of the engineering advances of the European cars.

A few weeks ago, several enthusiasts from the local area went on a rally to Starved Rock, Illinois. A rally is not a race in any way, shape or form. The



William Doty won a ribbon and a silver plate with his Triump TR-2 at the sports car show. (Photo courtesy Joe Stocks, Champaign-Urbana Optimists Club)



This little class H car was built by Don F. Kesler last summer. The car has an aluminum body and modified Crosley frame and suspension. The engine is a modified Crosley.

object of a rally is to maintain an average speed over a route that is unknown to you. This is no easy thing to do. Your navigator is madly making calculations while you worry about whether you are early or late. Now you shout more things for your navigator to calculate. You are watching unmarked roads and hope you hit the right one. Always on the lookout for secret check points, you ask about your time. The secret check points dictate that you always maintain the average and don't speed up and wait until the right time to get to the check point.

At the finish, the times and distances are compared to determine the winner. The person with the least deviation from the predetermined average wins. Phil Raeder, the winner of the Starved Rock rally, was only twelve seconds off after the first check point at thirty-two miles. Phil drove an MG-TF 1500. Don Westerberg took second in his MG special. Third place went to Bob Kay in a Jaguar.

Events would be a lot easier to plan if there was a sports car club in the Champaign-Urbana area. Regular meetings would draw more interest and would make it easier to delegate jobs necessary to stage an event. Other advantages of organization are discounts, movies of Sebring, G. P., and other races. These movies are available to clubs and are very good. A club keeps the group closer together by getting everyone together at once and saves time by not having everyone stop to find out about a coming event. News would circulate faster, and get to everyone.

The first job in organizing a sports car club is to advertise a meeting by placing notices on all sports cars and by word of mouth. Then bring some ideas about your club rules and requirements to the first meeting. Set up your constitution the first meeting so as to have a vote the second meeting. Get a committee started to stage a rally before a month. It is important to stage an event shortly after the start of the organization so that interest will not be lost.

Rallies can be staged to sports car races, state or national parks, or other interesting places. A small club is holding races on and surrounding a quarter mile track near Macomb, Illinois. A similar thing could be done near any quarter mile track, or abandoned airport. The Champaign County Fair Grounds has been used for a sports car field day.

The next thing to do is to keep the organization running smoothly. One of the best ways to do this is to show movies at the meetings and to bring a well known driver or organizer to the meeting in order to discuss secrets of staging events.

A sports car club is a good way to spread good publicity and to strengthen the field of sports cars. Every effort should be taken to further the acceptance and widespread use of sports cars. So far Detroit has made very little use of the latest developments found on sports cars. Perhaps with the growth of sports cars in America we will have some requirements such as four wheel independent suspension, overhead cams, and close ratio gears on American cars. When that day comes hot rodders will have good equipment to work with. But until that day, sports cars have the supreme advantage over hot rods.

Walking with a friend one day, a professor passed a large fish shop where a fine catch of codfish with mouths open and eyes staring were arranged in a row. The professor suddenly stopped, looked at them and(clutching his friend by the arms, exclaimed: "Heavens! That reminds me I have a class in CE this hour."

* * *

An engineer is a guy who is educated in the art of developing new and different ways of making the same mistake.

* * *

A small boy was seated on the curb with a pint of whiskey in his hand reading a racing form and smoking a big cigar.

An old lady passed and asked, "Little boy, why aren't you in school?"

The child replied: "Geez lady I ain't but four.

* * *

Teacher: David, what does F-E-E-T spell?

David: I don't think I know.

Teacher: Well, what is it that a cow has four of and I have only two?

The class was dismissed.

* * *

Leroy Brooks was assigned the job of writing up his senior class play in the high school paper. He came in for his share of literary fame when this write-up was published:

"The auditorium was filled with expectant mothers eagerly awaiting the appearance of their offspring."

* * *

Take for example rags. Rags make paper. Paper makes money. Money makes banks. Banks make loans. Loans make poverty, and poverty makes rags.

* * *

Mose was brought up for the fourth speeding offense. He muttered something under his breath that sounded like an oath.

"Repeat that," snapped the judge.

"Oh, I says, 'God am de judge, God am de judge.' "

* * *

OHM ON THE RANGE
OPUS 314—IN THREE PHASE TIME

Oh give me an ohm,
Where the impedances roam,
Where the field are not fluxing all day.
Where never you'll see,
A field without phi,
And the flux is not leaking away.
Ohm, ohm on the range.
Wheer the flux is not charging all day,
Where never is seen
A shunt field machine
With its armature running away.

THE ALUMINUM INDUSTRY WAS BORN ON SMALLMAN STREET

▶ In 1888, the aluminum industry consisted of one company—located in an unimpressive little building on the east side of Pittsburgh. It was called The Pittsburgh Reduction Company. The men of this company had real engineering abilities and viewed the work to be done with an imagineering eye. But they were much more than that. They were pioneers . . . leaders . . . men of vision.

A lot has happened since 1888. The country . . . the company . . . and the industry have grown up. Ten new territories have become states, for one thing. The total industry now employs more than 1,000,000 people—and the little outfit on Smallman Street? Well, it's a lot bigger, too—and the name has been changed to Alcoa. ALUMINUM COMPANY OF AMERICA . . . but it's still the leader—still the place for engineering "firsts".

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ALCOA ALUMINUM

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Hard Rock Shores of Lake Superior are Blasted for New Taconite Harbor

A new harbor for the transportation of taconite ore is being blasted out of the hard rock shore of Lake Superior, 75 miles north of Duluth, Minn. The operation is part of a $300-million project which will start feeding taconite to the nation's steel industry by 1957.

Construction of the 30-foot-deep harbor and its 2,444-foot-long concerte wharf requires the removal of approximately 1,000,000 cubic yards of rock over a 35-acre area, much of it under water. Three United States companies and one Canadian company own the Erie Mining Company which is responsible for the project.

The harbor is approximately 4,900 feet long and 1,500 feet wide. Two small islands joined by a rock breakwater will form the outer protection, and other rock breakwaters extending outward from the shoreline will safeguard the sides. Ships will enter one end of the harbor between the breakwaters and leave through the other end.

Contracting work began on the harbor in May, 1954 and is expected to be completed sometime in 1956. The harbor probably will go into operation late in 1957 when the Erie Mining Company's processing plant for taconite, 73 miles inland, is completed.

A new railroad will deliver taconite ore pellets, processed at the plant, to the harbor for loading into lake carriers. Ore cars will travel on a railroad trestle above the bins to discharge their contents. Lake freighters will be unloaded directly from the bins by means of conveyors.

To facilitate blasting and rock removal for the harbor, two cellular steel sheet pile cofferdams (watertight enclosures from which water is pumped to expose lake bottom) are being built around the excavation areas. The first cofferdam was divided into two parts so excavation could be carried on in one area while the second part of the cofferdam was being constructed. After the first portion of the main cofferdam was completed, water was pumped out and blasting began.

The harbor will be excavated to leave a vertical wall of rock which will be faced with concrete to form a solid dock. The ore-loading wharf is 1,200 feet long. On it will be mounted 25 concrete bins for loading taconite. Thirteen additional bins can be built on a 624-foot extension of the dock later on.

And then there was the E.E. who called his girl "Carbon" because her resistance went down when she got warmed up.

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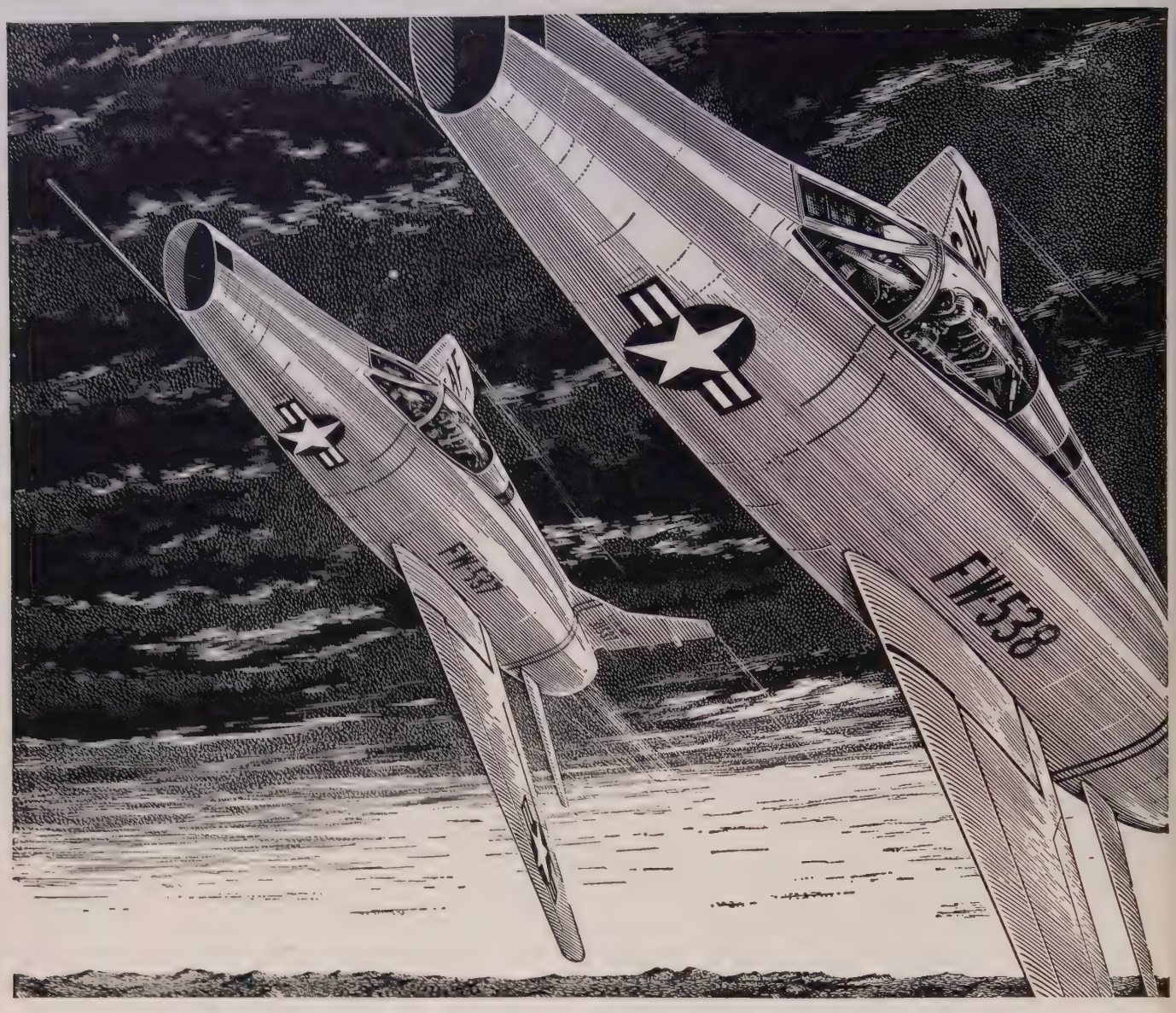

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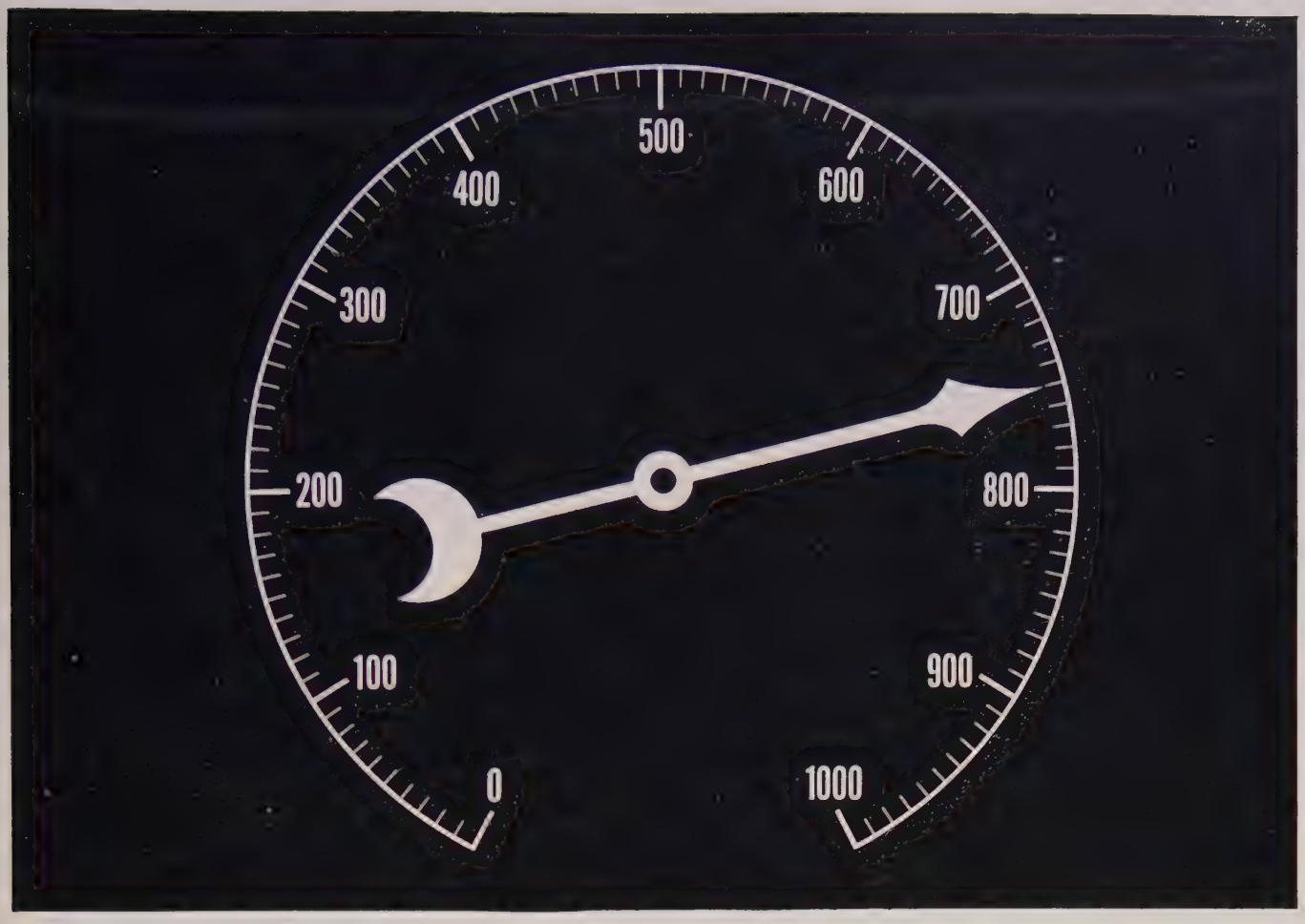

STORY TELLER...

Finding the origin of gages is as difficult as enumerating the types of service for which they are used. But all types of gages have one thing in common . . . they tell a story. They indicate what's going on in inaccessible areas . . . or measure things you cannot see.

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Go – Daddy Go!

by Donnie Snedeker, E. E. '58

"Drag, Buddy?" This simple often-heard phrase seems to exemplify the enthusiasm for a sport and a hobby that has taken hold of 50% of today's young men. More and more teen-agers are flying along this hopped-up highway to speed and power. They aren't content driving a Detroit wagon that will meet its waterloo at every stoplight. They want a car with super looks and super go-go-go.

Often times the beginner who sets out to soup up his car becomes lost in a maze of fact, formulas, and fantasies. He doesn't know where to begin to get the most for his dollar. As little or as much can be done as the individual wants, with prices ranging from a few dollars to have the heads milled to hundreds for the complete treatment. Basically there are five simple ways to power and speed which I shall attempt to elaborate here.

The first thing that invariably pops into the head of the newly-converted speed merchant is to either mill the heads, or replace them with a set of high compression heads. The increase in compression ratio shows a gain of 10 horsepower immediately. The performance becomes improved and the engine should operate more economically. All this is brought about because the gas is being compressed more, giving it a greater punch when it is ignited. As I mentioned before this increase in compression can be accomplished by installing a set of special high compression heads. The cost would probably run nearly $75. For less than one-third this price the heads can be milled (part of the underside of the head is machined off to reduce the volume of the combustion chamber), and for all practical purposes on a street job this gives almost as much increase in power as a set of aluminum racing heads. The average late model car has a compression ratio of about 6.8 to 1. Milling 0.120 in. off the head will increase this compression ratio to about 8½ to 1. Although you can go as high as 14 to 1 with special domed high compression heads, 8½ to 1 is about the best for general use on a street job burning pump gas. Any higher ratio would tend to give very poor low speed performance.

Second on our agenda to speed and power comes the cam shaft. No other single souping operation can add as much moxie to an engine as the installation of a high-performance, reground cam shaft. Many types of high-performance cams and regrinding operations are offered to the public, but for best performance the cam shaft should be reground to suit the individual engine. The semi or ¾-race grind is about the best-suited for passenger car use. It will work hand in hand with the high-compression heads to give increased power, performance, and acceleration while maintaining good low speed and idling characteristics. The function of the reground cam is to give the valves higher lift, longer opening, and more overlap. This produces greater volumetric efficiency which in turn nets up to 10 additional horsepower. The cost of the regrinding operation runs around $30 to $40 with very little means of cutting down on costs here. However, Chevvy owners can get around grinding the cam by using special high-lift rocker arms, instead. These perform the same function of holding the valves open a little longer, as does the racing cam, and they only cost $12.75 a set. V-8 owners should install a set of adjustable tappets with their reground cam to compensate for the amount of metal ground off the cam lobes.

The next thing that needs looking into is seeing that each cylinder gets as much fuel and air packed in with each intake stroke as possible. Most simply this is achieved by multiple carburetion. Aside from changing to smaller jet sizes, the stock automobile carburetor is very well-suited to this purpose. Whether dual or triple carburetion is used, the carburetors should all be of the same make and size. For proper distribution of the fuel to each cylinder these carburetors should be set on a special dual or triple manifold, whichever the case may be, that will have no constricting passageways for the fuel. The manifold must be large enough to handle the capacity of fuel needed by the engine. The cost of a dual manifold is in the neighborhood of $40 to $60. If this seems a little heavy on the green stuff there are "Y" adapters on the market for only $12.50. The "Y" adaptor allows the use of dual carburetion on a stock manifold with only about 10% loss in engine efficiency over the costlier manifolds.

The addition of the dual carburetors can add another 10 horsepower, increase top speeds, give better pick-up, and greater pulling power when they are bonneted with race-type air cleaners. These will allow the maximum in air volume and filtering with the minimum of dirt, dust, and engine choking. This addition of several carbs does not necessarily mean twice as much fuel consumption and lower mileage to the gallon; rather there will be better mileage in store because the engine will be getting full power from the fuel it burns and therefore go farther.

Another method of getting more fuel and air into the engine on the intake stroke is the use of a super charger, or blower as it's commonly called. The

supercharged mounts on the engine between the carbuetor and the motor. It sucks fuel and air through the carburetor and distributes the mixture under pressure to each of the cylinders. In effect, this greatly increases the amount of air and fuel in the mixture charge which in turn increases the punch, upon being ignited. In actual tests the addition of a supercharged increased the horsepower of a stock Ford V-8 as much as 30 per cent. In the past the cost of a supercharger has been too great, but recently McCulloch Motors of Los Angeles has come out with a noiseless, centrifugal type blower that is well within the grasp of the average enthusiast. And surprisingly enough it can be used throughout the range of modern automobile engines!

Now that we have paved the way for the greatest fuel mixture we must provide a quick, easy exit for the exhaust gases. The stock exhaust system has been very well termed by one writer as "an abortion fit only for the junk pile." Nothing constipates the engine more than the sharp bends and baffle plate mufflers that Detroit puts out. The back pressure holds back much of the exhaust gases which dilutes the fuel mixture charge and cuts down efficiency. This problem is easily solved. Even Detroit is beginning to realize the advantages of a dual exhaust system. Cadillac has had them for several years and now they may be had on nearly all cars as an extra in their power kits. There are many makes of dual exhaust setups which when combined with low pressure straight-thru mufflers give very little back pressure and produce a deep, mellow tone. Engineers show there is a gain of about one horsepower for each half-inch reduction of back pressure on the motor which gives us an additional 4 to 8 horsepower.

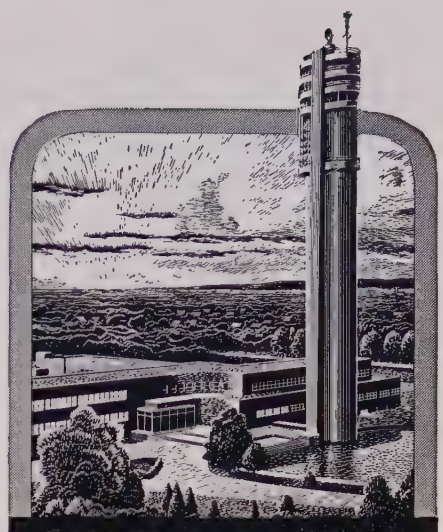
Our final step is one that will not necessarily add any horsepower but it can certainly steal the power if it is not kept up. This is the engine's spark of life—the ignition system. It's function seems to be the fairly simple task of igniting the fuel mixture in the combustion chambers. There's a little more to it than that. The battery provides the current but it doesn't have the oomph to jump such a spark on its own; so it is hooked up to a coil which steps the 6 volts up to as many as 30,000 volts. Of course, the spark has to be at the right cylinder at the right time. For this purpose we have a distributor consisting of breaker points, a condenser, and a rotor, which rotates to make contact with each plug in firing order. Each time the breaker points close a surge of juice from the battery builds up a magnetic field. When the points open the field collapses and a high tension surge produced in the coil travels to the rotor from which it jumps to the spark plugs in proper firing order. Each time the points open and close, the rotor rotates to make contact with a different plug. This process occurs about 10,000 times per mile.

Especially on a souped engine the ignition system must be at peak efficiency all the time. With the greater compression increasing the density of the gas mixture it takes a stronger spark to bridge the gap between the spark plug electrodes. Here, the best solution is a dual ignition system—two coils and two sets of breaker points. This would divide the 8-cylinder engine into two systems of four cylinders each, which would double the time allowed to build up the voltage for each spark and greatly reduce the wear on the individual parts. Also the spark plugs must not be forgotten. Under the extreme pressures in the combustion chamber the spark plug's center electrode tends to heat up resulting in premature detonation of the fuel mixture. To prevent this loss in power, spark plugs of the proper heat range must be selected according to the dictates of the individual engine. Generally speaking, a slightly colder plug is usually used on hot engines.

Although the five steps just mentioned are, I think, the basic steps in soup-up operations, there are still many things that may be done to the engine. We can gain about 5 horsepower by porting and relieving, which consists of enlarging the diameter of the intake ports and grinding away some of the block between the valve ports and the cylinders, allowing the engine to breathe better. The cylinders themselves can be overbored up to 0.120 inches, giving more cubic inches of fuel to the cylinder which, in turn, produces approximately 20 more horsepower. Naturally, overboring means we must switch to oversize racing pistons which are designed to operate at the higher compression ratios. We may now add more cubic inches and an additional 10 horsepower by stroking, which merely means increasing the length of travel of the piston within the cylinder.

If we have come this far we should now balance the engine. In a hopped-up motor with its extra horses and higher rpm, every ounce of weight that is off-balance becomes pounds of fury with but one thought—to tear the engine apart. By grinding off superflous metal from the pistons and cam rods we can balance the engine, which would remove all vibration and double the engine's life.

Now that we've gone all out on the engine there still remains the transmission and rear end gears. With a more powerful engine we may use higher gear



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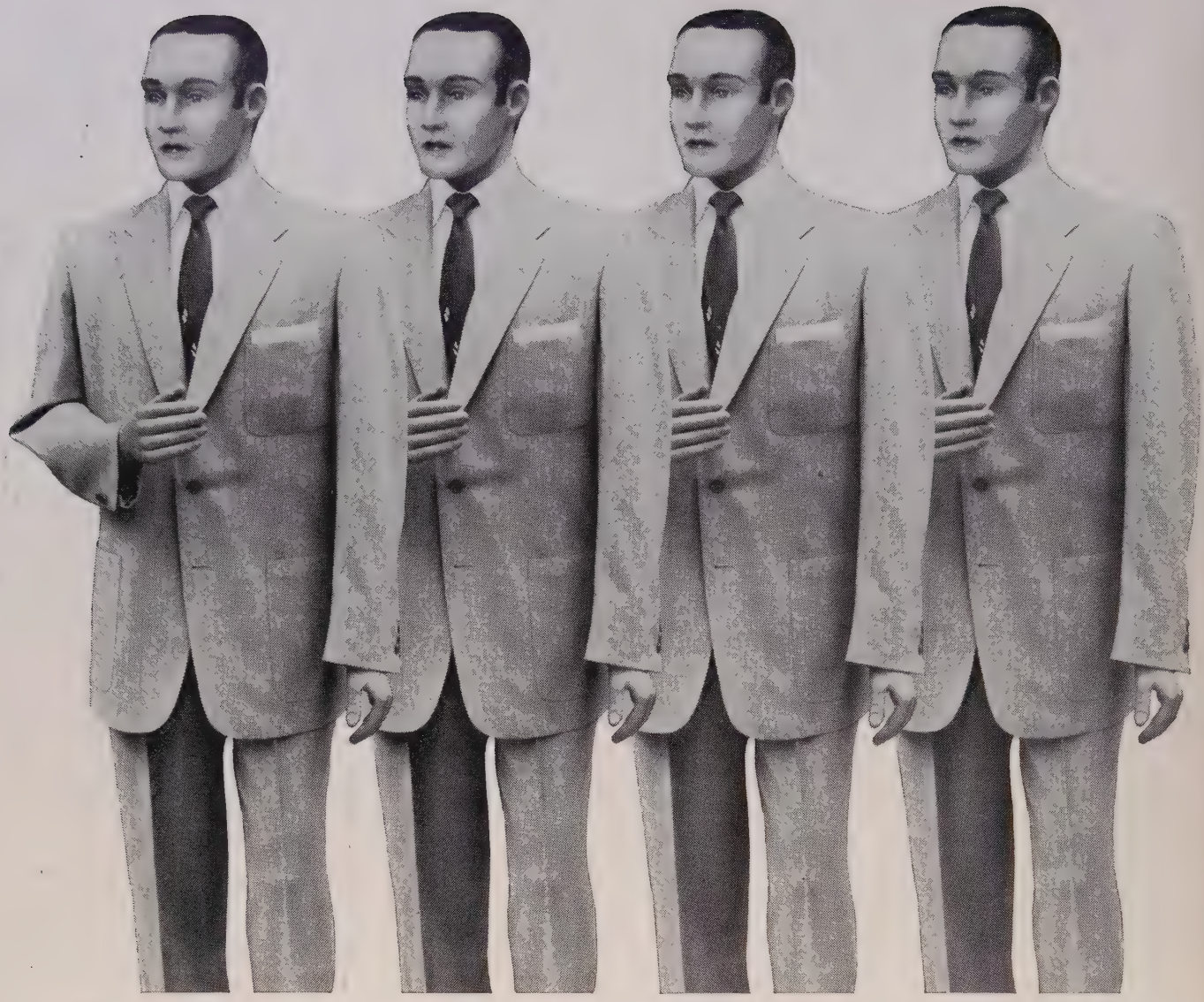

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1922—Roll-out of a Boeing-built fighter

1954—Roll-out of America's first jet transport, the Boeing 707

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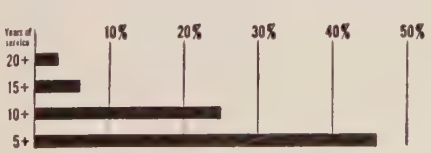
One measure of the satisfaction of Boeing careers is given in the chart below. It shows that 46% of Boeing engineers have been with the company for five or more years; 25% for 10 or more years, and 6% for 15 or more years.



Here are other advantages: Boeing promotes from within and holds regu lar merit reviews to assure individual recognition. Engineers are encouraged to take graduate studies while working and are reimbursed for all tuition expense.

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ratios. Generally speaking, higher rear end ratio gives higher top speeds, and higher transmission ratios produce faster acceleration. Both changes will give greater economy because the car goes farther on one engine revolution. A set of Lincoln Zephyr gears in the transmission will give better jump at the stoplight, and if we switch to larger gears in the rear end we'll have more go at the top end. In fact, the engine will be winding itself out with gears that are holding it back if the stock rear end isn't replaced with a higher ratio. About the best choice for city driving would be 4.11/1 or 3.78/1 gears with best gas mileage around town. A cheaper and very common practice is to replace the rear tires with larger ones. Just switching from 6.50x16 to a 7.00x16 tire will produce a gain of about 4 to 5 mph.

Well, the rod goes now but will it go safely and stop safely? No one wants to be flying along in the 100 mph-plus range and suddenly have a threadbare tire give out. The tires must be in top condition with plenty of rubber at recommended pressure because if the baby's shoes wear out, what's she going to walk on.

Even with the best shoes they have to have shocks that will keep them planted firmly on the ground. Poor shocks will bounce the car up and down like crazy, making control very hard to keep. The best type shocks are probably the tubular hydraulics with double-acting action. This means they will dampen the spring action on the way up as well as on the way down. After the shocks are mounted in a slightly-angled vertical position they should be checked regularly for leaks, worn mountings, etc. The shocks may be checked by bouncing up and down on each corner of the car. If the car continues to bounce after the pressure's taken off, there's something wrong with the shock on that corner and it should be looked into.

Although we have good tires properly suspended, we want to be sure we can stop on a dime if the need arises. Bugatti, maker of the world famous sports car of the same name, once said, "We make our cars to go, not to stop." That sounds like a pretty good policy until we suddenly see that bridge ahead is washed out. Not being able to swim, we want to stop! This is best accomplished with well-adjusted hydraulic brakes. Hydraulic brakes, which work on the Pascal principle (confined liquids transmit pressure equally in all directions without loss), should be used to replace the mechanical brakes on all pre-1938 cars. Hydraulic brakes eliminate the constant adjustment needed by the obsolete mechanical ones. But the flexible hose connections should always be kept in good shape, the fluid kept at the proper level, and the brake linings adjusted. As the brake linings wear down, they must be adjusted nearer to the drums to compensate for the wear.

Possibly there are a couple of other safety features that should be mentioned here. Safety belts are becoming increasingly popular through articles telling how statistics prove that is safer to ride an accident out with the car. Flying through the windshield or being plastered against the dash is definitely not recommended. For approximately $10.00 this can be virtually eliminated with the installation of aircraft-type safety belts. To be safe safety belts they should be bolted to the frame and have a simple release buckle. The belts can even be purchased in colors that will harmonize with the car's interior.

The other safety feature is localizing and extinguishing a fire, should one occur. Undoubtedly, one of the hottest spots to be caught in, is in a rod that is on fire. This usually occurs from a defect or sudden break in the fuel system. The best protection is to have a metal firewall between the driver compartment and the engine. The fuel for the fire can be cut off by a shut-off valve on the dash. This shuts off the flow of fuel to the engine and all that's needed then is a good fire extinguisher to put the fire out. The fire extinguisher, itself, may be mounted beneath the dash for easy access. As the old and true safety slogan goes, "The life you save may be your own." So why not?

Now that we have a car that goes and stops faster and safer, let's see if we can't improve upon the exterior appearance. Lowering the body gives us better driving and handling characteristics as well as that long, low, ground-hugging look. The main thing to guard against is excessive lowering which clearly invites bumper dragging and banged-up exhausts while driving over rough roads or up inclined driveways. Also if the back end is lowered the front end should also be lowered to prevent a tail heavy appearance which actually harms handling characteristics.

There are three basic ways to attack the lowering problem—altering the suspension, lowering the chassis, channeling the body. Altering the suspension, though not the best method, is probably the most practiced and certainly the cheapest. Fords, from '32 to '48, have transverse leaf springs which are easily lowered by installing long spring shackles. The shackles come in lengths up to 6 inches which, when used, lower the body the same amount. When the shackles are used there is a tendency for the car to sway from side to side. This is prevented by the installation of anti-sway bars which may be obtained at most speed shops. The anti-sway bar is stock on post-war Fords.

Later model Fords and other makes of cars have their springs mounted parallel to the frame. Here the problem of lowering is solved with the use of lowering blocks. The springs are attached to small pads under the axle by use of U-bolts. By replacing these pads with larger ones and longer U-bolts we can lower the car a subsequent amount. On late model cars this takes care of the rear end, but the coil springs on the front end pose a different problem. Some enthusiasts torch their springs to bend and shorten them. But the best method is probably to add an extension to the outer end of the lower A-arm and raising the inner end of the upper A-arm. The two A-arms will have the same relationship to each other and the car will be lowered by about 3 inches in the front. The necessary equipment for this lowering job may be purchased in kit form for $37.50. The lowering blocks for the rear would run about $3 to $4.

Probably the best method is to lower the chassis. And the best method of lowering the chassis is to "Z" the frame. This may be done by increasing the curve of the frame rails over the rear axle (cutting notches out of the frame, then bending up and over the notched points), or by cutting through the frame at 90° back near the axle, then lowering the front part of the rails the amount wanted and welding in reinforcing plates at the top and bottom to make the joint a single unit. These processes can lower the car about 5 inches in the rear; and then a dropped, or "dago," axle may be purchased for the front end from most speed shops, or the previously described method of lowering the front end may be used.

Channeling is slightly more expensive and more complicated. The cost is around $600 and it involves removing the entire floor section; then the body is dropped down around the frame; and the floor section is rewelded in a higher position and possibly the fenders will have to be raised to allow proper turning of the wheels. New supporting brackets usually have to be welded to the frame to properly secure the body. This method reduces the height of the body without lowering the chassis, thereby maintaining good ground clearance.

If the car has been lowered and the overall height still seems too great, as is often the case with older model cars, the thing to do is chop the top. This consists of cutting a section out of the top all around the window line, dropping the top, and rejoining it to the body. It sounds pretty simple but it is really a more complicated job than should be handled by the novice. The top doesn't always fit just right and usually requires some tricky patching.

hammering, and welding to get a decent looking job. It's almost like taking a section out of a cone and trying to get the top to fit properly onto the bottom part. Therefore, a price of $400 for a late model car top chopping should not appear too surprising.

Another method of lowering the overall height is to section the body. It is similar to top chopping but much more complicated and consequently twice as expensive. A strip is cut from around the middle of the car body, and then the top half is lowered to be welded to the bottom half. It is easily seen that this is extremely more intricate because of the many body contours you have to place your cut around. Because of the great expense this is a practice seen only on the most radical customs.

And now to de-chrome our car. Dechroming is probably the most seen customizing trick because it is rather inexpensive, and does change the appearance of the car considerably while retaining its basic good lines. The hood is the first thing we see, so naturally it would be the first item to de-garbage. The emblem, hood ornament, and chrome stripping is removed and the holes are brazed in, smoothed, and primed for about $20. If it is something such as a late model Ford with a center molding, the hood will probably have to be peaked which would make the price $50 more.

However, these processes are fairly simple and most enthusiasts who can use a welding torch may accomplish these tasks themselves. The holes that would remain when the side chrome strips are removed are easily filled in and the price of about 75c per hole is saved. Likewise the removal of all exterior chrome from the rear deck may be done by the individual. This involves the removal of the trunk handle and possibly license plate light and bracket.

When this shaving operation is completed we must find a way of opening the deck. Of the various possibilities the cable catch (like the hood release) is the least expensive. When the driver pulls a cable the trunk catch is released. Slightly more expensive is the electric solenoid catch. A solenoid is connected by a cable to the trunk latch and wired to a button on the dash. The dash button trips the electric solenoid which opens the trunk latch. Installation costs about $25.

An electric solenoid can be used to open the doors and roll the windows if the handles are removed. This operation works in the same way as the trunk solenoid catch. The buttons may be placed on the dash inside or on the inside of the door, itself. The outside buttons may be concealed in the chrome stripping and are of the type that may be made inoperative with a door key. Or they might be placed beneath the door and actuated by pressing with the foot. The price of these installations would be in the neighborhood of $75 for either the doors or the windows and they may be purchased in kit form from most speed shops.

After these major operations there remains but a few steps to complete before painting the car. The headlights may be frenched to enhance the picture of the front end. Whether the flush rim style or the recessed style is used depends upon whether the car is wanted to appear longer or shorter. The chrome rims on the headlights are brazed to the fenders. These are smoothed to appear as one continuous line and the adjustment of the light is then controlled from beneath the fender. Frenching serves to make the fender line longer, higher and more racy.

Much the same effect may be achieved in the rear by frenching the tail-lights or replacing them with different tail light lenses or units. A popular tail light unit that can be fitted into many panels without too much alteration is the late model Pontiac. Many enthusiasts have molded Cadillac fins on the rear. This operation costs $100 a side complete and is very effective on cars whose natural fender line is much the same as the Cadillac's. On cars whose natural fender line does not conform to Cadillac's the price would be slightly higher.

The front end treatment can be completed by installing a different grille. Sometimes a complete strock grille assembly from another make car can be fitted very easily. If this is not the case or not what is desired, straight grille bar kits may be purchased from most speed shops for about $30. Even a specially designed grille is not too expensive. A one-of-a-kind custom grille may be designed and constructed by the individual. Tubing or bar stock can be shaped and bent into the chosen design and then chromed before installation.

If we have all the body work completed we are now ready for the finishing touch to the exterior. A cheap paint job should not even be considered because it is the paint job that most reflects on the owner. The only choice lies between enamel or lacquer. An enamel job costs about $75. Lacquer runs about twice as much but involves much more work. Lacquer is the choice of most custom owners because of its greater depth and luminosity. A good lacquer paint job consists of about 12 coats with each coat being rubbed to a smooth surface before the application of the next. Another reason for the choice of lacquer over enamel is that lacquer may be chosen in either clear or metallic surfaces while enamel may be chosen only for texture.

The final aspect of customizing that will be covered is the interior! Much of the interior treatment is done to the dash. The simplest change is to paint the dash to match the exterior finish. They may be painted in one complimentary color or they may be two-toned. Two tones should definitely be considered if there is a natural division in the dash. The possibility is even there for half color and half chrome. Chrome should only be considered for the bottom half, however, because a heavily polished top section would reflect the sun's rays like a mirror and could be very annoying.

Another change that might be included in the dash treatment is replacing the stock instruments with different or newer ones. Many accessory gauges might be added like a tachometer and a Perfometer (a meter which registers performance in such ways as acceleration, pulling power, hill climbing ability). The knobs on the dash, the door knobs, and the gear shift knob may be painted, chromed, or, many enthusiasts are doing now, the knobs might be made of lucite plastic. They may be one color or they may be composed of 3 or 4 slabs of different colored plastic. The effect is very striking!

And now for the final task—custom upholstery. The most popular is the pleat and roll, but there is no limit to the design one may choose. The upholstery should be chosen to compliment the exterior finish of the car and is usually of two contrasting or complimentary colors, itself. The expense of leather usually leads to the choice of Naugahyde as the material to be used. After the seats are carefully inspected the upholstery is fitted in the chosen design over generous layers of foam rubber.

Sooner or later we'll be waiting to upholster the rest of the interior, so we may as well do it now. We do the door panels, kick panels, and side panels in a design matching that of the seats. The headlining is usually done in a solid tone with contrasting beading running across every so often. Custom floor mats are of a heavy duty, first quality rug material. It should be of a darker color that will not show the dirt too easily. Small 9x9 colored rubber mats may be placed on each side to protect the rug, especially on a muddy day.

At last the car's finished! All that remains is to fill the gas tank, turn the key in the ignition, and sink back into the foam rubber as the little jewel bites into the pavement and blasts off, the duals emitting their mellow warning to all would-be challengers.

Thanks to:
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Allison Engineers Pioneer Turbo-Prop Development

YC-130

YC-131C

William J. Layne received his B.S. in Aeronautical Engineering from Purdue University in 1950. Before joining the Allison engineering staff, he served as a captain in the Air Force 1942-46 and 1951-53. Bill, now a Flight Test Engineer, is shown taking gas turbine compressor readings from the equipment used to start turbo-prop engines at the Allison Test Facility in Indianapolis.

ALLISON is out in front, leading all U. S. aircraft engine manufacturers with more turbo-prop flight experience than has been accumulated by all of the nation's other engine manufacturers combined.

That's because Allison—working closely with the military—was a pioneer in the design, development and production of both engines and propellers for turbo-prop aircraft. First flight with an Allison turbo-prop engine was made in a Boeing B-17G at Indianapolis in 1949. Today, eight different types of military aircraft—including the VTO's—are making history with the Allison Turbo-Prop.

The Allison Turbo-Liner, shown above, was America's first turbine-powered, commercial-type transport. This flying test bed, which is a Convair 240 converted to Allison Turbo-Prop engines and Aeroproducts propellers, was the forerunner of modern military transports such as the Lockheed C-130 and the Convair YC-131C. After its first flight in 1950, the Turbo-Liner was used primarily as an engineering flight test aircraft, checking out problems for military application. More recently, the Turbo-Liner has been used on demonstration flights to show the many advantages of a turbo-prop powered transport. To date, the Turbo-Liner has made nearly 700 flights and has accumulated nearly 500 hours of flight time.

Now available for commercial application, Allison Turbo-Prop engines and their matching Aeroproducts propellers today are setting new standards for transport aircraft in speed, load-carrying ability, and economical operations.

Looking ahead, with our extensive development and expansion program, we need more engineers to carry on in a field where you'll find unlimited opportunity. We have immediate openings for the well-qualified, technically-trained, young graduate who is interested in starting his engineering career with a recognized leader in the industry. Allison representatives are interviewing prospective June graduates now. Write for further information: R. G. Greenwood, Engineering College Contact, Allison Division of General Motors, Indianapolis 6, Indiana.

GM AIRCRAFT POWER

Allison DIVISION, GENERAL MOTORS CORPORATION, Indianapolis, Ind.

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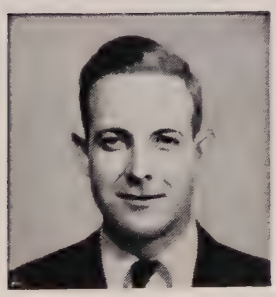
Jerry Loucks asks:

What sort of work would I do on my first assignment with Du Pont?

R. GERALD LOUCKS is currently working toward his M.S. in Chemical Engineering at Carnegie Institute of Technology. Jerry has served as president of his student chapter of A. I. Ch. E. and participated in intramural sports—besides finding time to play the trumpet in the R.O.T.C. and Kiltie bands. Right now, Jerry is giving a lot of thought to the selection of an employer.



CHARLES W. LOUNSBURY, Jr., worked at Du Pont's Chambers Works for three summers before he received his B.S. in Chemical Engineering from Rensselaer Poly. Inst. in 1940. Since then he has taken an M.S. from Carnegie Tech., and has been continuously employed on interesting assignments at various Du Pont plants. Today Charlie Lounsbury is Technical Superintendent of the Grasselli, N. J., plant of Du Pont's Grasselli Chemicals Department.

Charlie Lounsbury answers:

There is a great variety of first assignments at Du Pont, Jerry, depending on a man's field of training and the general area of work he has selected. For example, I understand you're interested in plastics, and you might start in *development work* on plastics, as I did. I worked with a team of more experienced engineers to increase the capacity of equipment used in producing "Lucite" acrylic molding powder. This was a natural prelude to my next major assignment, where I acted as a liaison between Du Pont's *Design Division* and the plant group—on the design of a new plant for making another form of "Lucite" plastic.

Or take *research work*. Here a new man is generally assigned to minor research problems until he becomes familiar with the general features and requirements of an industrial research program.

A young man interested in *sales* may start in a plant or laboratory dealing with the products he will later sell; or he may join a group of trainees to learn selling techniques right from the start.

A man aiming for *production supervision* may first spend a year or so in laboratory or plant development work. Or he may start as an operator—in a plant producing nylon or "Dacron" polyester fiber, for example. In this way he obtains firsthand knowledge of his process, and establishes a bond of mutual respect with the men he'll be working with on his major assignments later.

In general, Jerry, a man is chosen for a specific job within the scope of his major field of study. His first assignment is intended to help him make the best use of his abilities as promptly as possible.

WANT TO KNOW MORE about working with Du Pont? Send for a free copy of "Chemical Engineers at Du Pont," a booklet that tells you about pioneering work being done in chemical engineering—in research, process development, production and sales. Write to E. I. du Pont de Nemours & Co. (Inc.), 2521 Nemours Building, Wilmington, Del.

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BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*
WATCH "CAVALCADE OF AMERICA" ON TELEVISION

From a Tee-Pee to a a Two o'clock

by Dave Templeton, '56

Note to Reader: This story is entirely fictitious. Anyone who knows the author knows he would have to work hard to even swing a deal for a pair of second hand roller skates, much less a Mercedes.

The weather was fine that day. It was Spring and I still had a few hours before I had to get to my two o'clock class. So, I packed a few sandwiches and jumped into my Mercedes and zoomed out of Champaign-Urbana. I'm used to driving the highways around here, so I decided to try the first dirt road I came to. Throwing my little baby into second, I made a right turn, up over a rise and down into a gully and then over a bridge. (I suspected the little river was feeding into the mighty Bone Yard Creek.) I'm not a wild nature lover, but I had to admit that the day was great. Riding along under the trees and along side the bushes was putting me into a class cutting mood when a little figure jumped out into the road. When I was almost on top of him, I realized it was that little Indian I had met last year, Chief Tech-i-engi-graph. (Chief Tech will have to suffice since it gave the printer trouble fitting such a long name onto the page.) Even though I had met him before, I still found it hard to believe that this was a genuine Indian talking.

"Hi there, Dave. Say, that's a cool crate you got there, man." See what I mean. And he's an Illini Indian, at that.

"Yeah," I smilingly answered. "It's a little something I picked up on a wild spur of the moment." I hoped he didn't notice my right wrist where the auto dealer had cut, extracting my last payment. "Hop in. Give you a buzz in it." I had come to like this little character and I knew that a ride in a sports car would really give him a thrill.

"Swell," he said, opening the door. "I was just about to ask you if you could give me a lift to town, Dad."

Well, to say the least, this little guy had really gotten jazzed up in his lingo. I figured it must have been the influence of being in a sports car. He was obviously getting a big charge out of the whole thing: sitting in the seat, feeling the upholstery, smiling to himself and his feather flapping in the breeze.

"How much this cost you, Dave."

"The down-payment wasn't bad. Why? You interested in getting one?" I tried to hide my pity for this poor little fellow.

"No, no, I just wondered. It's real cool, man; there should be one in every tee-pee I always say."

"Definitely," I said with as much conviction as I could. "Are you a sports car fan?" Being a fan myself, this was a subject dear to my heart. My only fear was that it wasn't a topic my little Illini friend didn't delve in. Just by looking at him . . . his little buckskin pants, the loin cloth over it, and his little feather which must have been won in combat with some lady's Shaparelli hat a football game in Memorial Stadium, I assumed he wasn't too well off. He was a brave little fellow, indeed.

"Oh, I look them over now and then," he answered casually.

"How do you get around in these sticks? Do you have a pinto?"

He threw me a look that cracked the left lens of my glasses. "Come off it, Dad. The era of horses for Indians has passed. Haven't you seen me around campus in my . . ."

"Say, there's the highway," I hastily cut him off. I didn't want him to feel ashamed telling me how he got around. He was undoubtedly going to tell me about his wagon or something along those lines.

"Great! When we hit that pavement and if there aren't any cars on the road, open it up a little bit." I looked at him. He had sense. He would make a good driver some day. He had the makings of one . . . saying, "open it up a little," and "if there aren't any cars on the road." Those two statements make the difference between a crazy, mixed up driver and a good one. I got onto the highway and we were driving along when another sports car was approaching. "Uow there's a . . ."

". . . Lancia," he interrupted.

"Hey. That's right. How did you know?"

"Don't be so naive. I think you've got us still pegged for tee-pees, horses, and totum poles."

"You mean you don't have those anymore?"

"Only when the tourists come around. But the tee-pees are prefabs even then."

"Oh," I answered in my most worldly manner. I always liked uttering profundities such as that.

"Gad! You must have a real good group on the campus. That was an Allard and a Gutbrod that just went by weren't they?"

"Yes," I gulped. I had hoped my surprise over his knowledge of foreign cars was not too noticeable. After rolling my tongue up (which had fallen into my lap) and neatly placing back into my mouth, I continued my sparkling conversation.

"Yes," (I was picking up where I had left off). "Say, you seem to know your cars, don't you?"

"Oh, I get around," he said easily, putting his moccasined foot up on the dashboard. We had just passed the outskirts of Champaign-Urbana and were moving toward Green Street.

"Any place in particular you'd like to go?"

"Yeah, make a left turn two blocks down and go over about three. This I did, being careful not to ruin the crease in the pants of the policeman who I ran over at the intersection.

The place where he wanted me to stop was coming nearer. I felt a pang of sympathy for this little Chief Tech. "Well," I said trying to hide my emotion and turning on the defroster to my glasses, drying the tears which were starting to trickle down my cheek. "I guess this just about ends your ride in my car. I hope you'll get another chance to ride in one someday . . . whether it's mine or someone else's."

"Oh, don't take it too hard, Dave. Here. This is where I want to get out." We stopped in front of a gas station."

"This is where you want to go?" I asked.

"Yeah. Well, thanks a lot, Dad. It's been a real pleasure riding in a Mercedes for a change."

"For a change?" I asked. But he didn't hear me. He had gone inside. Just as I was about to pull away, the door to the garage part of the service station rolled up. A Jaguar roared out and pulled up alongside of me.

"Well, here's hoping we run into each other again, Dave. Figuratively, of course." With that little Chief Tech zoomed off.

It took a little while to get my composure back again. Not that I was amazed by all this, but I didn't take my car out of first all the way to my two o'clock tee-pee . . . er class.

One day in November, the wife of a factory efficiency expert asked her young son what he wanted for a Christmas present.

"A little baby brother," he said.

The mother stammered a bit, then managed to protest, "There's too little time."

To which the boy asked innocently, "Couldn't you put more men on the job?"

* * *

A father and his young son, who carefully held in his lap a shoe box punctured with air holes, were seated in a bus. When the bus stopped for a red light, the lad was heard to ask, "Daddy, is my kitten a man kitten or a lady kitten?"

"A man kitten," said the father promptly.

"How do you know," the boy continued.

Every passenger within earshot waited expectantly for the reply.

"Well," explained the father, "he's got whiskers, hasn't he?"

* * *

The professor signed his name on the blackboard and followed it with B.S., M.S., and Ph.D.

A freshman leaned over to his neighbor and asked him the meaning of the letters.

"Well, you know what B.S. means, don't you?"

"Sure."

"Then, M.S. means more of the same and Ph.D. means piled higher and deeper."

* * *

Did you ever note how often a narrow mind and a wide mouth go together?

* * *

We understand that manufacturers of certain feminine garments are currently making only three kinds: The Russian type, the Salvation Army type and the American type.

The function of the Russian type is to uplift the masses.

The function of the Salvation Army type is to raise the fallen.

The function of the American type is to make mountains out of mole hills.

* * *

One reason the football season is such a popular time of the year is because it is the only time a man can walk down the street with a blonde on one arm and a blanket over the other and not encounter raised eyebrows.

* * *

Salesman: "Sir, I have something here that's guaranteed to make you the life of the party, allow you to win friends and influence people, help you forge ahead in the business world, and in general make life a more pleasant place and invigorating experience."

Engineer: "I'll take a quart."

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HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

SCIENTIFIC AND ENGINEERING STAFF

Culver City, Los Angeles County, California

Photograph above: Engineer-writer John Burnett (left) works with engineers John H. Haughawout (right) and Donald King to compile handbook information.

Bendix JET IGNITION

THE tough job of lighting a match in a tornado will give you some idea of the problem of firing a jet engine on the ground. Even more difficult is refiring the engine in flight should a flame-out occur—especially at high altitude.

Up there you not only have to reckon with low-volatility fuel but with rarefied air rushing through your engine at super-hurricane speed. Here, you can be certain, is a mixture that violently resists igniting!

Our Scintilla division at Sidney, N.Y., developed a special ignition system with the answer: a super-spark hot enough to fry a rock and of sufficient duration to fire and refire jet engines quickly. It has worked so successfully that, today, Bendix-Scintilla† Jet Ignition Systems have been selected as standard equipment by most of the leading jet engine manufacturers.

Nation's Foremost Source

Bendix-Scintilla is known to engine people everywh as the nation's top source of supply for ignition eq ment. Most military planes rely on our ignition, an doubt if you can ride on a commercial airliner that i sparked by Bendix-Scintilla. Your power lawn mo farm or garden tractor or outboard motor may h one of our many types of magnetos developed for s applications. Leading automotive manufacturers exp menting with turbojet engines in passenger cars, tru and buses are using Bendix-Scintilla Jet Ignition.

Continual research and years of practical field o ation have fitted us to anticipate and solve igni problems; and that's why engine manufacturers, see advice, talk to Bendix-Scintilla people.

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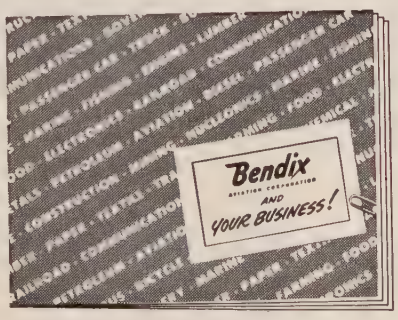

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ANALYZE YOUR CAKE AND KEEP IT TOO – WITH X-RAY

by Vern W. Palen

Research & Control Instruments Division North American Philips Co., Inc.

In these days of tough competition when manufacturers are striving to turn out new and improved products, it becomes increasingly important to know as much as possible about materials.

Undoubtedly, there are vexing problems in your laboratory and shop that defy solution or are costly by ordinary methods. You may have questions which involve identification and measurement of elements and constitutents of compounds that should be answered. Perhaps there are some unsolved mysteries in your plant processes that need clarification.

X-rays can do these jobs for you without harm to your specimens. If your laboratory studies and production control problems are chiefly concerned with compounds and the atomic structure of materials, *you need the X-Ray Diffractometer.* When your investigations merely deal with elements present in a substance, *then get yourself an X-ray Spectograph.*

Specimen preparation is relatively easy. The usual precautions must be taken, of course, to be sure that is truly representative of the lot from which it is selected. In some cases, the specimen will be powdered and seived. In other instances, it need only have its surface polished. Most important, it will come back to you unharmed after the analysis, a point of extreme importance when dealing with rare or costly materials.

Once the specimen is ready and is inserted in the X-ray Diffractometer or the X-ray Spectograph, the instrument takes over in semi-automatic fashion. The operator merely sets the controls to obtain the desired results, then waits for the answer, usually in the form of a strip-chart on which a hill-and-valley curve is recorded.

For production control the chart may not be needed. For example, where one wishes only to check presence or absence of specific elements or other constituents, the instruments can be set up to give rapid visual answers. In such cases, preliminary laboratory chart investigations are the basis for later shop procedures.

Fig. 1 shows the essential components of the X-ray Diffratometer and X-ray Spectograph. It will be noted that the two instruments are very much alike, except that the Spectograph has an *analyzing crystal.*

Whereas the Diffractometer detects and records all rays diffracted from the specimen, the Spectograph "screens" some of the rays before they reach the Geiger counter. The crystal acts as a diffraction grating, resolving and dispersing the various wavelengths like an optical grating handles visible and ultra violet radiation in the optical spectograph.

Long wavelengths of X-radiation are dispersed to higher angles and the shorter wavelengths to lower angles. The crystal separates the various wavelengths sufficiently that each may be individually detected and intensity can be measured.

Since the intensity of the characteristic radiation from a given element is proportional to the percentage of the element present in the specimen, the intensity as measured by the Geiger counter may be used in quantitative analysis.

Fig. 2 shows a complete Diffractometer and Spectograph installation. The wide-range goniometer is shown (left) in operating position on the table top of the X-ray generator. These two units plus the electronic circuit panel (right) are components of the Diffractometer.

The Spectograph uses the same X-ray generator and electronic circuit panel in conjunction with the special X-ray tube and goniometer assembly shown on the center cabinet. Unitized design minimizes equipment investment since it permits double usage of the major components.

When an analysis is completed on either of the two X-ray instruments, the result is a strip-chart showing a hill-and-valley curve. Fig. 3 shows a typical Diffractometer chart.

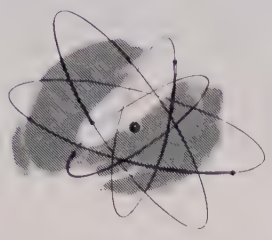
To convert this information into useful terms, certain reference data must be available. Books and card file systems can be obtained which list angular locations and intensities of X-ray lines for thousands of chemical and metallic substances.

The chart of Fig. 3 is for quartz and the three highest peaks occur at 26.58°, 20.90°, and 50.10° (two theta). From a handbook, these angles are interpreted to mean equivalent atomic lattice spac-

Complete installation of X-ray Diffractometer and X-ray Spectograph. On left, X-ray generator and wide range goniometer. At center, special horizontal X-ray tube and goniometer assembly for X-ray Spectograph. On right, electronic circuit panel and strip-chart recorder.

12 of the basic industries in which Bendix products play a vital role

ELECTRONICS



ATOMIC ENERGY

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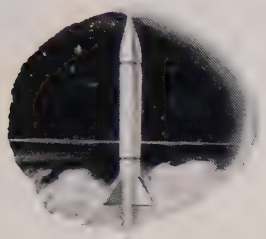

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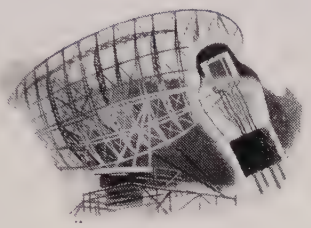

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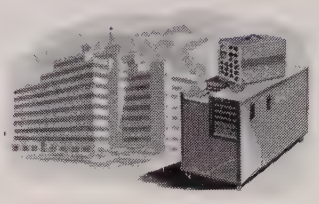

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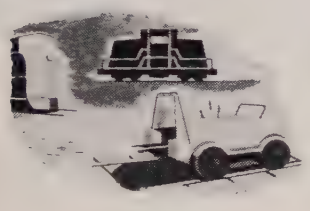

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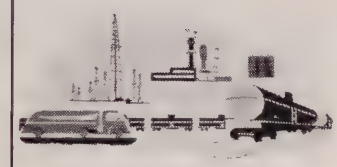

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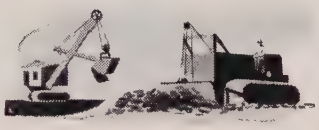

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A SOUND REASON WHY Bendix OFFERS TODAY'S ENGINEERING GRADUATE AN UNLIMITED FUTURE!

Diversification is an important asset in business.

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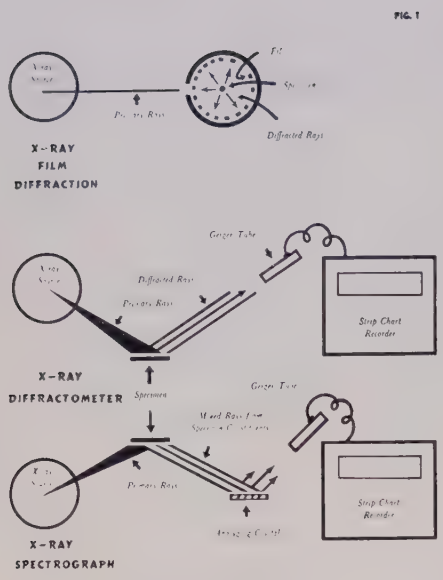


Components and geometrical arrangement of the X-ray diffractometer and Spectograph.

ings (d) o f3.35, 4.24 and 1.81 respectively.

For quantative work with the X-ray instruments, it is necessary to have standard specimens for comparison with the unknown. If standard specimens having known quantities of these elements are analyzed on the Spectograph, then peak heights on the charts can be related and calculations can be made for the unknown. Since most production line problems are concerned with variations in well-known specimens, the analysis procedure is frequently quite simple.

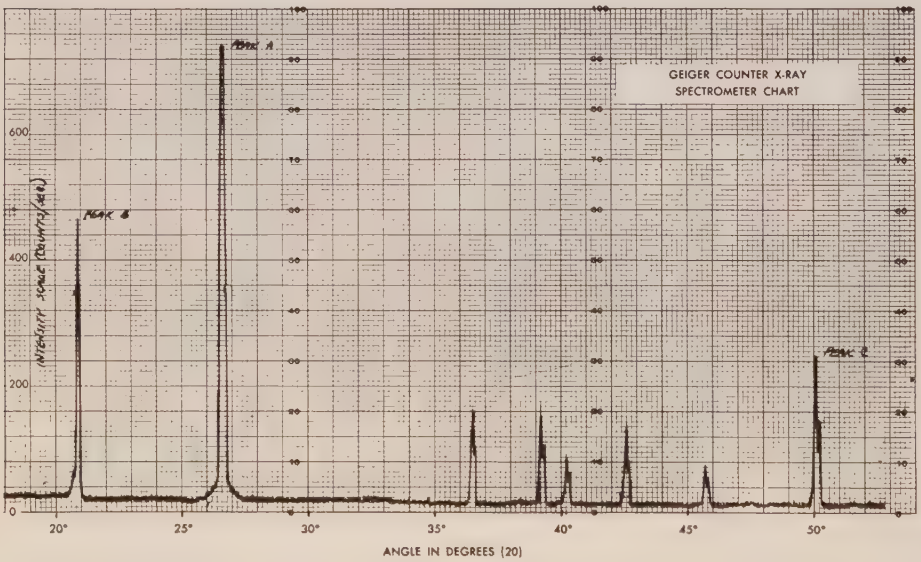
One recent new field in which X-ray analysis has been applied effectively deals with thin films. Coatings of six micrograms per square centimeter of stainless steel were readily identified on plastic base materials. In other words, the new technique easily and quickly determines percentages of chromium and nickel present in a specimen of 18-8 stainless steel where one square centimeter of the film actually contains about one microgram of chromium and less than one-half microgram of nickel.

Micro X-ray spectography techniques have distinct potentialities for evaporation control through rapid analysis of rates of deposits from solvents or through checking tiny quantities of condensate. Flash coatings, used for protective and decorative purposes, can readily be controlled as to thickness—a process heretofore extremely tedious and difficult, as well as inaccurate.

Air contamination and industrial plant flue recovery are important fields in reducing outputs of hazardous smokes, and in recovery of valuable by-products. Machine friction, a subject of great interest in aircraft, automotive and stationary engine design, is now susceptible to more efficient attack by analysis of thin films. This technique gives clues to the transfer of metals in the formation of superstrata alloys under heat and pressure. It will also reveal the degeneration o fbearing surfaces due to chemical interaction with constituents of lubricants.

In many fields of metallurgy, micro X-ray spectography will be useful in studies of molecular or atomic migration at interfaces, particularly in the case of laminated metals.

In criminal investigations, where quantities of materials are often in the microscopic realm, stains, smears, inks, friction pick-ups and ingested poisons in small amounts are potential problems for the new thin-film method.



X-ray Spectograph chart for specimen containing silver, copper, nickel, and chromium. Accurate quantitative data is obtained by comparing height of peaks for unknown with known samples.

Techno-Cutie

PEGGY ANN HOOVER is the pretty miss who adorns the pages as TECHNO-CUTIE this month. Peggy, who is 20 years old, is 5 feet, 3½ inches tall and she weighs 104 pounds. She has blonde hair, blue eyes, and for statistical minded engineers, the dimensions from top to bottom are: 34-22-34. Peggy has a host of activities on campus which leave her no spare time, the main one being the female lead in the spring musical, "Good News". As a resident of Champaign, Peggy is "Miss Champaign-Urbana", the queen of the Twin Cities. She appeared on the Horace Heidt talent show and last summer she was the lead in an opera at Tanglewood, the nationally known summer camp. Peggy resides at Alpha Omicron Pi, and she is a member of Sigma Alpha Iota, the professional music fraternity. At last word, Peggy tells us she isn't pinned, engaged, or married, so if you can find her some spare time the field is open.

According to a certain E.E., the boys over in E.E. lab have developed a new whiskey test, which runs like this:

Connect 20,000 volts D.C. across a pint of fluid. If the current jumps it, the product is poor.

If the current causes a precipitation of lye, tin, arsenic, iron slag, and alum, the whiskey is fair.

If the liquor chases the current back into the generator, it's darn good stuff.

* * *

The old engineer pulled his favorite steam engine up to the water tank and briefed the new fireman. The fireman got up on the tender and brought the spout down all right, but somehow his foot caught in the chain and he stepped into the tank.

As he floundered in the water, the engineer watched him with a jaundiced eye.

"Just fill the tank with water, Sonny," he drawled. "No need to stamp the stuff down."

* * *

Class Reunion: Mixing of old grad with Old Grandad.

A DREAM COME TRUE

by Robert J. Marks, Aero. E. '58

One of the most fantastic and expensive cars in the world today comes from one of the relatively poorer countries in the world. The country is Spain, and the car is the Pegaso.

The Pegaso is a combination of the best engineering principles that are known today. It is truly an idealistic creation for which no expense has been too great to materialize this dream car.

The engineer responsible for this magnificent piece of machinery is D. Wilfredo Ricart, formerly associated with Alfa Romeo. He is now working under the auspices of the Empresa Nacional de Autocamiones of Madrid, a company that was formed in 1946 to manufacture trucks and buses. The Pegaso is its first attempt at producing a passenger car. It is manufactured in Barcelona in what was formerly the old Hispano Suiza factory. The Hispano-Suiza is considered by many people to be the finest car produced in the post World War I era. The first new car that was turned out of there was the Pegaso Z-102, in 1953.

Since then, the Z-102 has been modified, and at the present time there are three versions offered by the factory, ranging in price from $15,000 to $35,000.

Although none of the ideas in the Pegaso represent any revolutionary departure from familiar principles, the fusion of so many delicate and expensive features is quite rare. The idea of quadruple camshafts in itself is quite staggering to the imagination. When you couple this with the fact that power output would increase steadily up to a theoretical, though unattainable, 9,000 revolutions per minute, you may have some idea of just how fine a piece of machinery this car is.

Like any other new car, the Pegaso has had some "bugs" in it and has not done anything spectacular in competition, to date. It cannot be doubted that when all the "bugs" have been eliminated, this one-ton, 150-horsepower car will eventually turn the tide in racing history.

Because of the quality of the car in conception and manufacture, the cost is understandably quite high. Although, if a car of this calibre were to be constructed in America, it would only be feasible as a million dollar experimental model, made by some Detroit manufacturer.

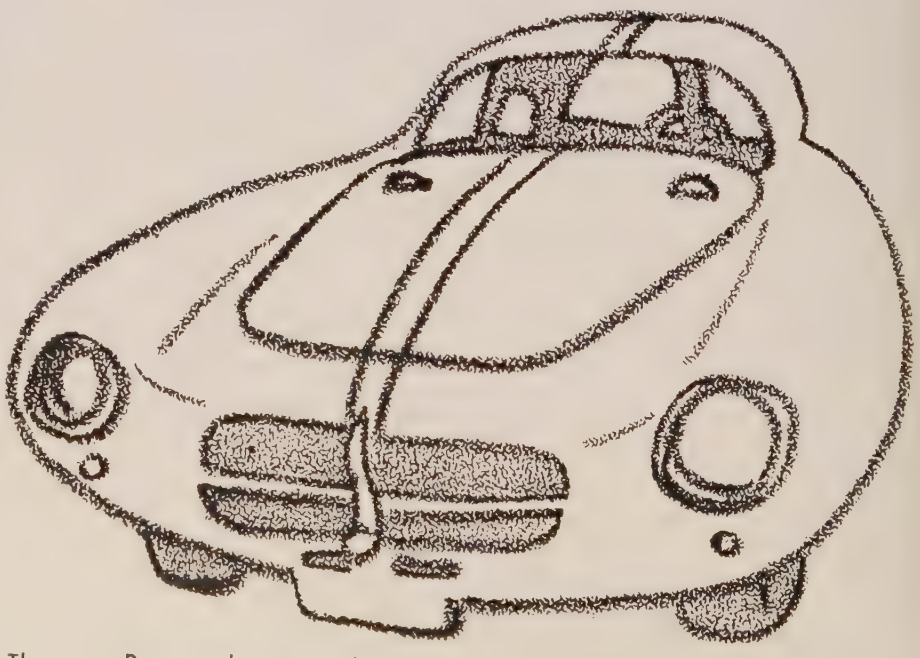
The three models now in production are a 2.8 liter (171 cubic inches) model, a supercharged 2.8 liter model, and a 3.2 liter (195 cubic inches) model that is also supercharged. The different models are so designated by their piston displacement. Body styles at the present time are five in number. They are an aerodynamically designed sports Berlineta designed by Pegaso's own styling department, a Berlineta two-to-three seater sports coupe by Touring, a two-seater hardtop convertible and a two-seater sports coupe by Saoutchik, and a radically designed semi-glass-roofed three seater by Touring that looks like something straight from a Buck Rogers adventure. The car has very appropriately been named "Thrill."

The engine design is a composite of all the accepted best features of today's reciprocating internal combustion engines. It is a 90-degree V-8 with an over-square bore and stroke, with hemispherical combustion chambers and inclined valves that are actuated by a pair of overhead camshafts for each bank.

In plain and simple everyday language this merely means that the two rows of four cylinders each are at an angle of 90 degrees with each other. An over-square bore and stroke is so called when the diameter of the cylinder bore is larger than the distance that the piston travels on one stroke. Some of the many advantages of this type of set-up are that the distance that the piston travels at a given R.P.M. is reduced producing longer piston life and less friction.

Hemispherical combustion chambers are just what they are implied to be—hemispheres. The advantage of this is to produce even burning without preignition developing from "hot spots" in the combustion chamber. The best valve arrangement is generally conceded to be the set-up in which the valve actuating mechanism is coupled as directly as possible with the fewest moving parts. What could be more direct or positive than the actuating of each set of valves by its own camshaft!

The four camshafts, each of which runs in five bearings, are driven either by triple roller chains or by a gear train,



The new Pegaso demonstrating its unique top-side entrance. The car has 150 horsepower and weighs approximately one ton.

IN 1943, JAMES H. BENNETT, JR. WAS A JUNIOR ENGINEER. SINCE 1953, HE HAS BEEN MANAGER OF THE ELECTRO-MECHANICAL DEPARTMENT. Opportunity awaits YOU during the next decade at Martin.

IN 1942, WELCOME W. BENDER WAS A VIBRATION ANALYST. SINCE 1952, HE HAS BEEN MANAGER OF THE ELECTRONICS DEPARTMENT. Opportunity awaits YOU during the next decade at Martin.

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Aerodynamics	Propulsion
Airframes and Structures	Electronics
Control Systems	Mechanical Design
Armament	Thermodynamics
Nuclear	Instrumentation
Hydrodynamics	Dynamics
Servo Mechanisms	Electrical

WRITE AT ONCE

to

JOHN M. HOLLYDAY

P.O. BOX 988

MARTIN

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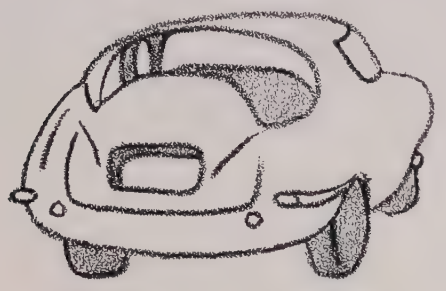
depending on the model engine. Hard liners are set in the cylinder-block, which is cast as an integral unit with the crankcase in a very light but rugged alloy. The pistons are connected with twin connecting rods. A dry-sump lubricating system with an oil radiator is used. This, in other words, means that the lubricating oil is in a sealed system that does not drain into the crankcase but instead flows through the engine and then back to the oil radiator where it is cooled and recirculated.

The advantage of this system is that



the crankcase can be removed for inspection of the bottom of the engine without having to drain and refill the crankcase with oil. Carburetion set ups vary from the using of one to four Weber dual down-draft carburetors.

On the unsupercharged 2.8 liter models, there are three choices of compression ratios. They are 7.8 to 1, 8.2 to 1, and 8.8 to 1 compression ratio, this engine develops 130 horsepower at 6300 revolutions per minute. This is comparable to the Studebaker Champion six-cylinder engine developing as much horsepower as a Ford V-8 truck engine that has 239 cubic inches of displacement.

The standard transmission for this engine has five forward speeds ranging in gear ratios from 13.09 to 1 to 3.78 to 1, plus an overdrive. This certainly would be a transmission-shifters dream come true. This gearbox is mounted in a rear extension of the differential housing.

There is also a variety of optional equipment available for this engine, such as a special Bosch magneto ignition system to replace the standard coil and distributor type.

The story on the supercharged models is entirely different. The compression ratios on the supercharged 2.8 litter engine range from 6.5 to 1 to 7.5 to 1 with a 6.0 to 1 ratio on the 3.2 liter engine, which is only available in the supercharged models.

There are many advantages in supercharging an engine. When dealing with an engine of small displacement, some method is needed to boost the torque output. Supercharing is the answer. The fancy engineering terminology for it is "pressure induction." Since the power output of an internal combustion engine depends basically on the weight of the fuel/air mixture it can burn per minute, one of the best ways to raise the output of any engine to its maximum structural capacity is to "blow it," as supercharging is sometimes referred to. Supercharging is nothing more than pumping the fuel/air mixture into the cylinders instead of relying on suction.

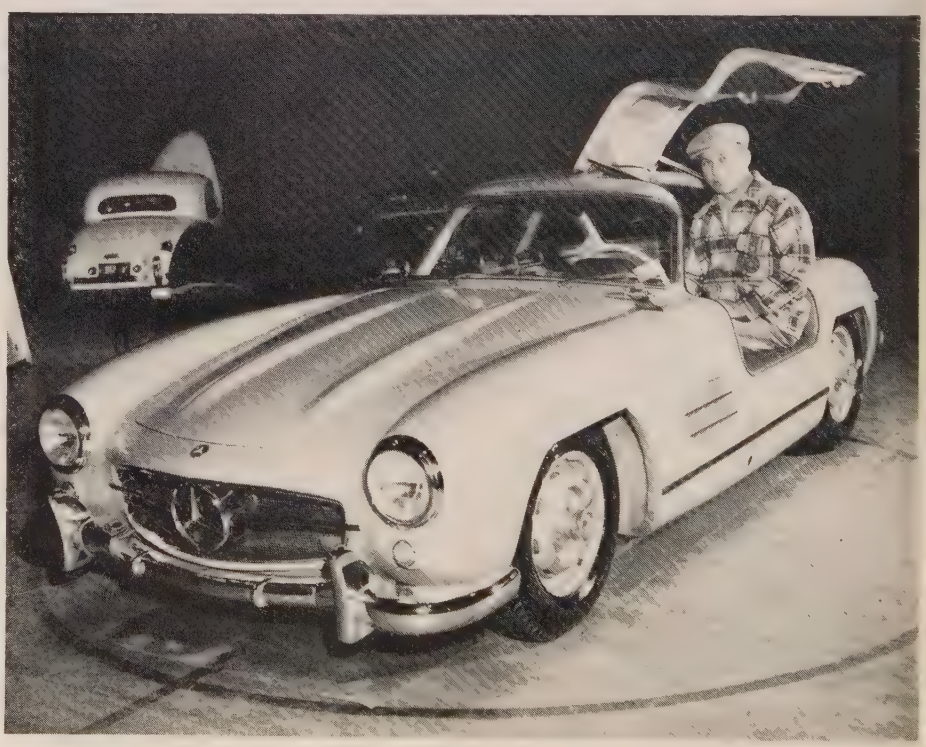
The supercharged 2.8 liter engine, using a compression ratio of 6.5 to 1 develops 190 horsepower @ 6500 revolutions per minute. The 3.2 liter engine, raving a bore of 3.35 inches and a stroke of 2.76 inches, develops 260 horsepower @ 6500 R.P.M.'s. Again comparing it to stock American cars, it is the same as the Rambler engine developing as much power as the new Packard V-8 engine that has 352 inches of displacement.

With a wheelbase of 92 inches and the tallest model standing a mere 51.34 inches, it can well be called a small car. The Pegaso's chassis design is just as unique and perfect as its engine. Front suspension consists of torsion bars in front and behind the unequal-length wishbones, while transverse torsion bars are mounted across the rugged but light tubular frame in the rear. This type of suspension—torsion bars— has just been adopted by one of the American automotive manufacturers, Packard, although their method of mounting them differs from the Pegaso's. With a tread of 52 inches, a 17 inch-diameter steering wheel and a special worm screw steering gear requiring only 1.7 turns from lock to lock, handling characteristics of the car are phenomenal.

The Pegaso has a turning diameter of only 30.1 feet, which is a little over two American passenger-car lengths. The turning diameter is the diameter of the circle the right front wheel would make when making a left turn with the wheel all the way over. Again this may be compared to the smallest turning radius of American cars by making a contrast to the Rambler's 36 foot turning diameter. Ground clearance of the Pegaso ranges from 5 inches to 6.3 inches, depending on the model. This is a little bit less than the American average ground clearance but is still enough to avoid hitting the driveshaft or parts of the chassis on a rough road.

To stop this wildcat, there are large Lockheed hydraulic brakes on all four wheels. The rear brakes are mounted inboard on the split deDion rear axle. The mounting of the brakes in this manner, plus the rear mounting of the transmission and its own oil pump, plus the deDion rear-end assures a minimum of unsprung weight and the best possible traction under all road and weather condtions. Total braking surface is 190 square inches, which gives an unusually high braking area—between 132 and 136 square inches per ton. This is welcome knowledge when fast and positive stopping is required.

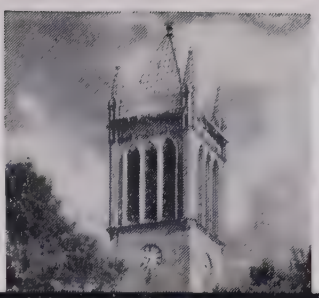
Another unique feature of this braking system is that the brakes function by two independent hydraulic circuits—something that American manufacturers



Dr. Urbas, the owner of this new Mercedes 300 SL sports coupe, recently took fifth place in a 550 Porche in the twelve hour Sebring race. This car with 183 cu. in overhead cams can do 160 m.p.h. (Photo courtesy Joe Stocks)

WISCONSIN

MICHIGAN



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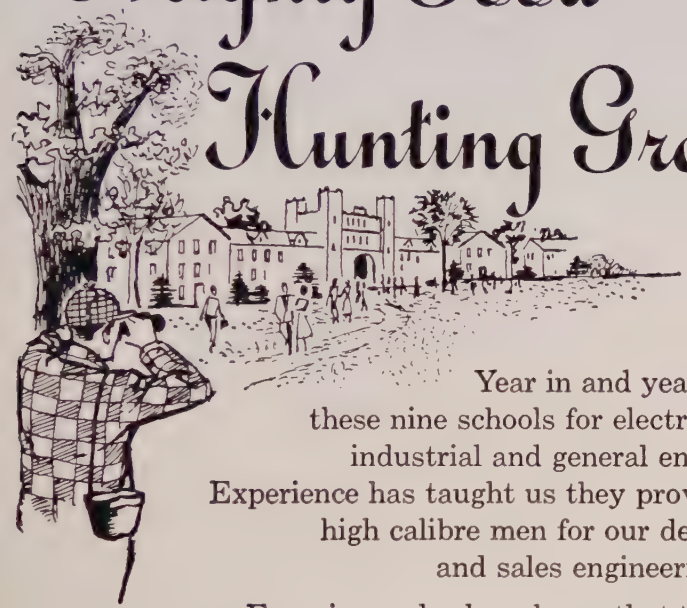

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would do well to copy, merely as an added safety device.

With a dry weight ranging from 2200 pounds on the unsupercharged 2.8 liter model to 2350 pounds on the 3.2 liter model, the cars are capable of top speeds of 115 M.P.H. to 144 M.P.H., respectively. However, the new 3.2 liter model has been unofficially clocked at 170 M.P.H. The Pegaso also has a pounds per horsepower ratio of 9.04 to 1, in the largest model. This is one of the lowest ratios in the world.

With all of these marvelous feats of engineering combined into one car, it might be thought that the Pegaso would skimp when it comes to comfort. Such is not the case. Comfort has been looked after with as much fastidious care as went into the engineering.

Every luxury item has been included from push-button windows to built-in traveling accessories. Most models also come equipped with thigh-style crash belts and shoulder harness as standard equipment—another hint that Detroit could do well to follow.

Among the company of outstanding racing and sports cars, the Pegaso is suer to hold its own, but one point should be brought up in connection with the car's records of the future. Who is going to take a chance on ruining such an expensive piece of machinery by rac ing it just for a trophy or a record?

The little tot was sitting demurely on the couch, watching her mother smoking a cigarette. Her nose was wrinkled, and in her pale blue eyes was an expression of child disillusionment. Finally, unable to stand it any longer, she blurted out in her quivering voice, "Mother, when in the hell are you going to learn to inhale?"

* * *

Pants are made for men and not for women. Women are made for men and not for pants. When a man pants for a woman and a woman pants for a man, they are a pair of pants. Such pants do not always last and then they are called breeches of promise. This often turns into a suit. When two couples are mixed up in a suit, all panting, it is a suit with two pair of pants.

* * *

"I'm going to have a little one,"
Said the girl friend, gay and frisky;
But the boy friend up and fainted
Not knowing she meant whiskey!

* * *

Poetry . . .
Both women and pianos
Are similar in brand . . .
Some of them are upright
And some of them are grand . . .

* * *

Lectures are like steer horns—a point her, a point there, and a lot of bull in between.

THE AUTOMOBILE OF TOMORROW

by Siegmar Gresch, M. E. '59

What will the car of tomorrow be like? Will it be a heavy car with a big engine or a light car with a small engine? In order to get a broad view of the possible future of automobiles we must not only look at engine and transmission design, but at the characteristics of the fuels and the total resources. The present trend in the automotive industry is toward higher and higher performance with little attention paid to economy. True, we talk about economy. But are we really seriously interested in economy? There are several factors coming into prominence now which will greatly affect the car of the future.

I. Increased taxes and cost of living tend to encourage more economical cars and lower first cost.

II. Future available supply of petroleum might enforce gasoline economy.

III. Crowded roads and existing parking conditions encourage smaller cars.

In comparing the performance of a big car against that of a small car, we shall compare the average American car with the average European car, keeping in mind that the acceleration is dependent on lb/per hp, while top speed is dependent on hp/per squ. ft. frontal area. Acceleration varies with the type of transmission. For example, a four speed transmission in the same car. Torque converters wasted power (10 to 12%) until newer models were developed that clutch out in high gear. The steady improvements of automatic transmissions points to more efficient automobiles.

What about top speeds? In comparing top speeds of cars of a few years ago, we find that the top speed of the expensive American car was about 100 M.P.H.; the top speed of the low priced American car was about 85 M.P.H., and that of the foreign car was 75 M.P.H. What good are such high top speeds? In most places the legal speed limit is far below such high speeds, and the only place where one can "open up" is on a trunpike. Even then, the average driver doesn't have the skill to drive a car at 70 M.P.H. Furthermore the horsepower required goes up closely as the square of the speed, so one can see that considerable horsepower increase will not affect the top speed very much. The only instance the foreign car is not quite as fast as the American car is in acceleration. But, the only time that acceleration is useful is when we misjudge passing someone on the highway or when we race the other fellow at the stoplight.

Comparing values of the average foreign car against the typical American car we have the following table:

	H.P.	Weight	Lb. per hp	Hp per sq ft.
American car.....	125	3,400 lb.	29 lb.	4.3
Foreign car.....	65	2,300 lb.	411 lb.	2.7

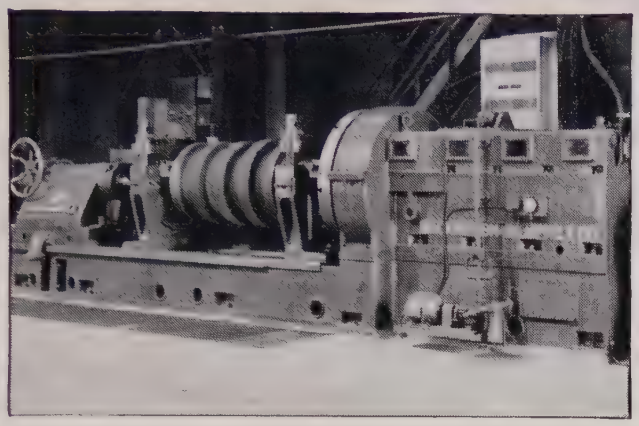
Comparing these figures, we see that the Europeans put 30% less material in their cars and use motors almost half the size of ours. Because the cars are smaller and have less air resistance their top speed is almost equal to ours. Why do we need such big cars? Surveys recently taken show that the average passenger load is 1.3 people. Why should we buy a heavy American car wherein it takes one ton of iron and a few hundred pounds of other material to lug around 200 lbs of flesh when we can do the same job with a ton of iron? In comparing cost, we find that the initial cost of the American car is 25 to 35% more than the popular foreign car. This is not all, let us examine the cost per mile with cars driven 10,000 miles a year.

Comparing figures one can see that the foreign car which is smaller and lighter is much cheaper to operate than the popular American car.

Another component of the automobile which is of considerable interest now days is the suspension system. Typical

Another page for **YOUR BEARING NOTEBOOK**

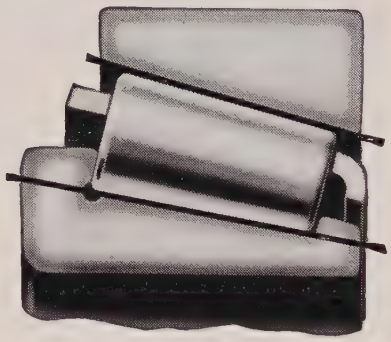
How to carry 35-ton loads in a roll-neck lathe



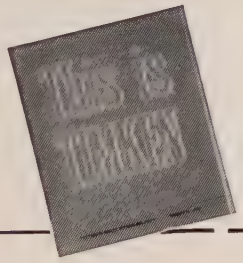
The engineers who designed this roll-neck lathe were faced with three problems. 1) To build a lathe that would cut finishing time as much as 75%; 2) To build a lathe that would give great accuracy and 3) To provide great load-carrying capacity as well. Their answer was this electronically-controlled mill roll lathe. To carry the 35-ton loads with a maximum runout of .0003 and still do the job quickly, they specified Timken® tapered roller bearings.

Why TIMKEN® bearings have high load capacity

This cross-section of a Timken tapered roller bearing illustrates one reason why Timken bearings do such a good job under heavy load conditions. Notice that there is full line contact between the rollers and races. It's this full line contact that distributes the load over a wider area, gives Timken bearings their extra load-carrying capacity.

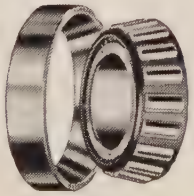


Want to learn more about bearings or job opportunities?



Some of the engineering problems you'll face after graduation will involve bearing applications. For help in learning more about bearings, write for the 270-page General Information Manual on Timken bearings. And for information about the excellent job opportunities at the Timken Company, write for a copy of "This Is Timken". The Timken Roller Bearing Company, Canton 6, O.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◐ AND THRUST —◎— LOADS OR ANY COMBINATION ✳

present day suspension systems employ coil springs for the front wheels and leaf springs for the back wheels. This system has several disadvantages. In order to get a soft, smooth ride, soft springs are used; and as a result, the car sinks a few inches closer to the ground when fully loaded; and hitting a hard bump results in scraping the rear bumper on the road. At high speeds the car tends to sway on the slightest bend of the road.

	Cadillac	Ford or Chev.	Average Foreign
Gasoline	.0205	.0164	.0100
Lubrication	.0025	.0020	.0015
Tires	.0069	.0035	.0028
Repairs	.0086	.0040	.0035
Miscellaneous	.0018	.0018	.0011
Total operating cost	.0403	.0277	.0189
License registration	.0013	.0010	.0008
Insurance	.0109	.0060	.0055
Depreciation	.0407	.0204	.0155
Fixed charges	.0529	.0274	.0218
Total cost per mile	.0932	.0551	.0407

Because the springs are so soft, the bulk of the work of providing a comfortable ride falls on the shock absorbers which slow down the action of the recoil of the springs. As soon as they are worn, the car acts like a rubber ball bouncing half a dozen times everytime it hits a hard bump. A different type of suspension used exclusively by racers and expensive foreign cars in the past has now been adapted to the production automobile. Packard has just unveiled their 1955 models which use a torsion-bar suspension. A single bar on each side of the car takes care of the suspension of the front and back wheels. Levers are connected to each end of the bar at 180 degrees to each other, so that when the right front wheel hits a bump and goes up, the bar is twisted in such a way as to wind up the torsion bar, putting force on the rear wheels. Because the torsion bar is not connected to the frame of the car in any way this action has no effect on the body or chassis, and the result is a perfectly smooth and level ride at all times. Torsion bar suspension is one of the most important recent improvements in passenger car suspension, and unless something better comes along it will be adopted by other automobile manufacturers in time to come.

Certain facts pertaining to gasoline, which have come out into the open may also force the automotive industry to improve their engine designs. In a report given by the Bureau of Mines and American Petroleum Institute, the fact was brought out that the octane rating of gasoline has reached a limit under the present system of catalytic cracking. This is borne out by the fact that the rating of all the major oil companies does not vary more than 2.0. Fuel injection, which would do away with the need for high octane gasoline, may be a possible solution to the increasing demand for high octane gasoline. As in the diesel engine, the fuel would be injected directly into the cylinders, eliminating the need for an intake manifold, making possible a tremendous increase in fuel economy. But because the tolerances have been even closer on a gasoline fuel injection unit than on a diesel fuel injection unit (since gasoline is less dense than diesel fuel) the high manufacturing cost would make the gasoline fuel injection unit impractical. In time new production methods may reduce the cost so that gasoline fuel injection units would be feasible. Whenever the question of fuel injection arises there is always some talk of putting diesel engines in automobiles. The only reason diesel engines are not used in automobiles is that they are too heavy. The great pressures encountered make it necessary to have very thick cylinder walls. In time, metals may be developed which are lighter and have greater strength than those of today and the diesel engine in the automobile may become a reality.

The only type of propulsion which may replace the reciprocating engine in the very near future would be the gas turbine. Using advanced production methods and a generator, a gas turbine could be produced that would compare in cost to the reciprocating engine. Fuel would be no problem since the need for octane rating would disappear. But because of the high temperature encountered in the gas turbine, alloys have yet to be developed so that the gas turbine can compete successfully with the reciprocating engine as a form of propulsion for the automobile. (See December 1954 *Technograph.)*

Safety features of future cars will play an important part in the crusade for safety on the highways. Power brakes together with power steering, will become standard equipment. Air conditioning, with its year-around temperature control, will be part of the standard equipment. In addition, padded dashboards and safety belts will increase the chances for survival in serious accidents.

After examining all the facts, the future points to smaller, smoother riding, more efficient automobiles. After all, it has been known for some time that engines of advanced design having 10:1 compression ratios have been run on 80 octane gasoline. Isn't it logical that some of these engine designs could be used in a modified form on present day engines?

The Volkswagen, commonly called VW, is fourth in sales in the world. The car is perhaps the best engineered passenger car in automotive history.

Superimposed over this man's head is the matrix (or heart) of RCA Electronic "Memory." See description below.

New RCA Magnetic "Memory" recalls thousands of facts in a fraction of a second

Each dot you see in the squares above is actually a magnetic "doughnut" so tiny that it barely slides over a needle point. Despite its size, however, each "doughnut" stores away one bit of information for future reference. And 10,000 of them fit on a framework smaller than the size of this page!

Here are the cells of the RCA magnetic "memory" that is the key element in virtually all high-speed electronic computers. The greatest significance of this "memory" is its ability to deliver, in a few millionths of a second, any information it holds.

Almost instantly, an insurance company can process a claim. Just as fast, a manufacturer with inventories spread around the country can determine what products are making money—and *where*.

With such "memories," electronic computers predict accurately the next day's weather for the nation, using data on atmospheric pressure, temperature, and wind velocity from every part of the United States.

The leadership in electronics that created this man-made RCA "memory" is responsible for one achievement after another in television, radio, radar and other RCA products.

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RADIO CORPORATION OF AMERICA

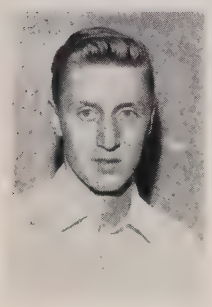
ELECTRONICS FOR LIVING

DUAL EXHAUST SYSTEMS

by Maurice H. Garnholz

Aero. E. '56

Although among true automotive fans and car bugs, there is almost unanimous agreement on the merits of a dual exhaust system for the present-day automobile, many others who merely drive their cars with only the exterior appearance of the automobile and its parts in mind scoff at such seemingly "juvenile hot-rodders." This article was primarily written for those who are more concerned with the interior workings of their car and, as almost every driver is, with the possibilities of higher performance and better economy.



MAURICE H. GARNHOLIZ
Maury, last year's feature editor, has been a contributor off and on to the TECH since his freshman year. As secretary of the Society of Automotive Engineers, secretary-treasurer of the Illinois Rocket Society, and member of the Institute of Aeronautical Sciences, he is kept quite busy.

By the end of 1953, the total registration of passenger cars, trucks, and buses in the United States had climbed to over 55,600,000. As is probably evident to almost everyone with a driver's license, highway building has failed by a dangerously wide margin to keep pace with the increase in vehicle population. Unless one picks the alternative of hopelessly bogged-down traffic jams, vehicles must have the ability to pass slower moving traffic quickly and safely. Greater flexibility in traffic, more power on hills, and more instant acceleration are almost a necessary requisite for ease of driving and consequent safety reasons. Even if the power isn't always used, it should be *available*. Improved performance which car manufacturers have built into their latest offerings has made it almost imperative for those who cannot afford the new models to do something with their current models in order to make them more responsive, if they wish to continue to enjoy driving on highways side by side with the better-performing later-model cars. This, perhaps, is the basic reason for hopping up; *i.e.,* increasing the performance of cars today.[1]

One of the first considerations (in fact, almost *the* first) in increasing engine efficiency and power must be the release of exhaust gases from the engine as quickly and smoothly as possible.

Just as holding one's hand on the front of one's face stifles breathing, so do many of the stock exhaust systems bother the breathing of present-day cars. By improving the intake and/or exhaust portions of the breathing cycle, the performance of the car will also be altered toward a higher degree of performance capabilities. Additional performance in the intake part of the cycle is accomplished by more efficient carburetion, intake manifold design, superchargers, air cleaning, etc. But these improvements at the intake portion of the engine's operation can only attain a point anywhere near their highest possible efficiency, if the best obtainable exhausting of the burnt gases is accomplished. For even if a better and faster means of getting the air and fuel mixture to the combustion chamber is accomplished, burnt gases will not be scavenged and removed rapidly enough without a correspondingly rapid and efficient expulsion of these burnt gases. Hence, it is almost mandatory that any improvement made at the intake end of the engine should be accompanied by a similar improvement at the exhaust end. This article is primarily concerned with the expelling of the gases from the running engine.

If one was running down the street and put his hand over his nose and mouth each time he attempted to exhale, he would not run very well, and obviously not at his maximum speed nor efficiency. The same is true of most exhaust manifolds, exhaust pipes, mufflers, and tail pipes. They create restrictions, like the fingers of the hand, resulting in excessive back pressure. Back pressure is a positive restrictive pressure in the exhaust system and is created by several contributing factors. The three most important ones in the form of restrictions can be attributed to (1) mufflers designed for silencing only in which the direction of flow of the exhaust gases is reversed several times, thus eliminating a smooth flow of these gases, *e.g.,* baffles in the muffler; (2) exhaust systems that are unable to handle the volume of exhaust gases created by the engine, thus making it impossible to vent these gases as fast as the engine creates them (This often comes about due to curling pipes and sharp corners in the bends.); and (3) an angular, rough manifold construction which prevents smooth, fast flow of exhaust gases.

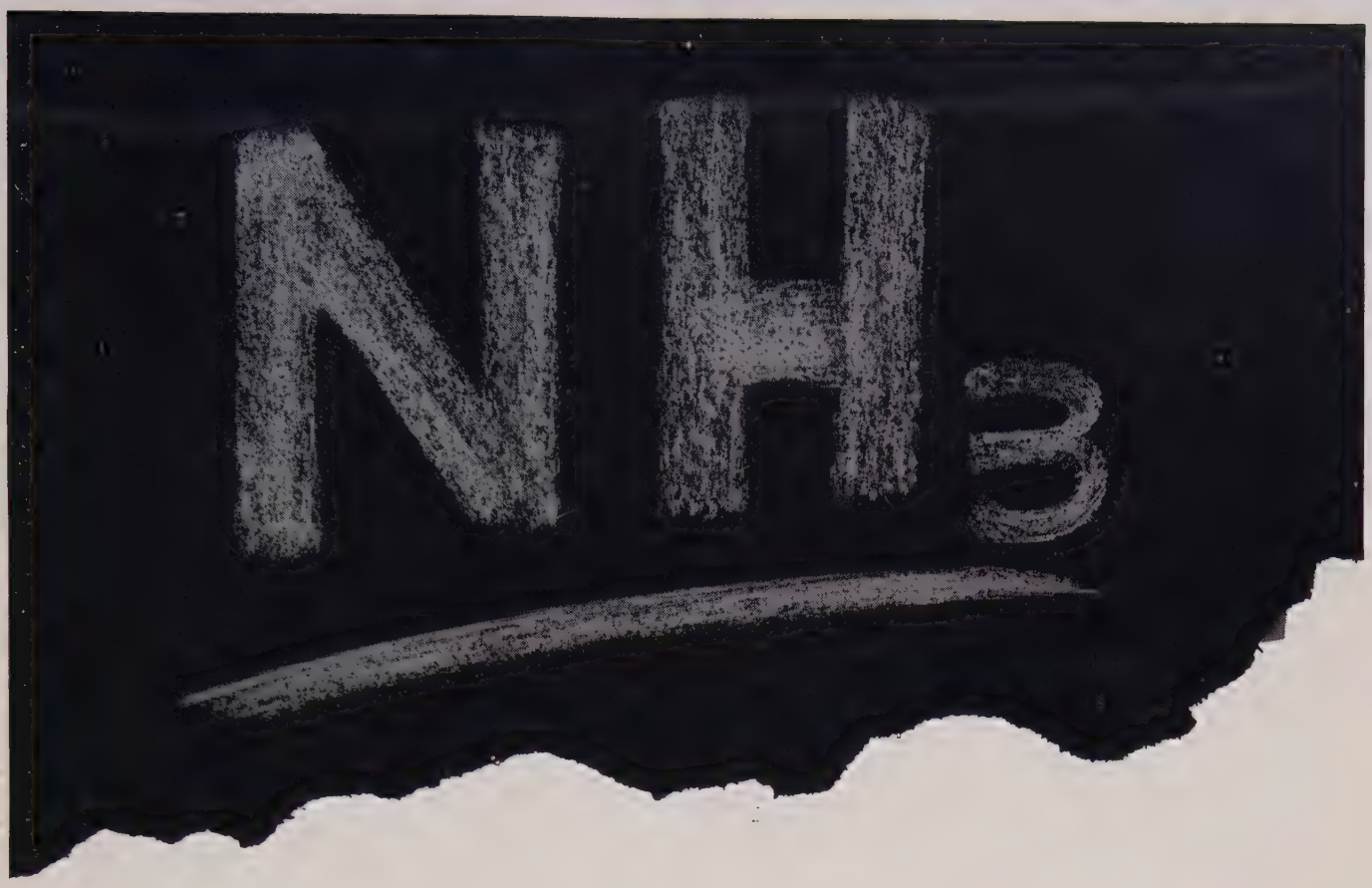
The installation of just one straight-through type muffler, which absorbs the noise by material surrounding a no-bend core, will give an average increase of about 5 per cent both in horsepower and economy (fuel consumption). This varies with car makes and often among the same models. With a dual exhaust system, the increase is *more* than twice this figure. It should be mentioned at this point that the carburetor must be adjusted with the installation of duals, as it was probably set for a single exhaust system previously. Hence, without a new carburetor setting, too rich a mixture of gasoline and air is obtained, which means a waste of gasoline occurs. This is because the dual exhaust system allows the car to run faster without burning as much fuel. Therefore, unused gasoline is just thrown out and wasted. But with a minor carburetor adjustment, the fuel consumption will drop.

These straight-through mufflers are usually packed with either steel shavings or fiber--glass, with the latter often capable of withstanding a temperature of over 1000 degrees Fahrenheit. Even on a stock system (one muffler), such a muffler often reduces back-pressure up to 50 per cent of its former value. They are usually blow-out proof and will often outlast three or four stock mufflers at a fraction of the cost, depending of course on the brand and the conditions they are subjected to.

From *Car Life's* "Economy Driving" is obtained the following discussion on exhausting the dollars. "Back-pressure in the exhaust system is a phenomenon of combustion that is becoming of increasing importance. In older autos it was a simple matter to carry away exhaust gases with relative efficiency through a single pipe. As engines have gained in compression, however, without corresponding additions in size and weight, the exhaust system has tended to resist the efforts of the engine to swallow more air on each cycle and expel it more rapidly (high compression). This resistance is known as back-pressure, and at full throttle may be as much as five pounds per square inch."[2]

By a dual exhaust system with non-restrictive mufflers, one can aid the engine in its labors by achieving a greater volumetric efficiency in the cylinders, which in turn will give a marked increase in acceleration and mileage as well as a cooler-running car.

Restricting our discussion to V-type engines although all improvements in performance apply almost equally well to in-line engines), the merits and whys of a dual exhaust system is further discussed. The conventional arrangement of the flow of exhaust gases in the V-type engines require that the gases leaving the left bank (or right) of cyl-



FORMULA FOR BETTER FARMING

THE PETROLEUM INDUSTRY seeks constantly to extract the ultimate in valuable and useful products from every barrel of crude oil. And progress along this line in one area frequently brings with it advances in other related areas.

For instance, improved catalytic reforming methods developed by Standard Oil have increased high octane gasoline yields. This improvement is accompanied by substantial increases in available by-product hydrogen, which can be combined with nitrogen from the air to produce ammonia. Standard has therefore completed plans to enter this important chemical manufacturing field.

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By simplifying inspection, this *Fafnir-developed,* slow running ball bearing torque tester shrinks the chances of error. Unlike some torque testers which require scores of readings to produce similar information, the Fafnir Torque Tester requires only one revolution of the bearing outer ring to record such characteristics as running torque in gram-centimeters, bearing defects (if any), where located (inner or outer ring), and the presence of dirt or excessive eccentricities.

The development of a better means of measuring instrument bearing torque is but one of many Fafnir contributions to the ball bearing industry. The Fafnir Bearing Company, New Britain, Conn.

NOTICE

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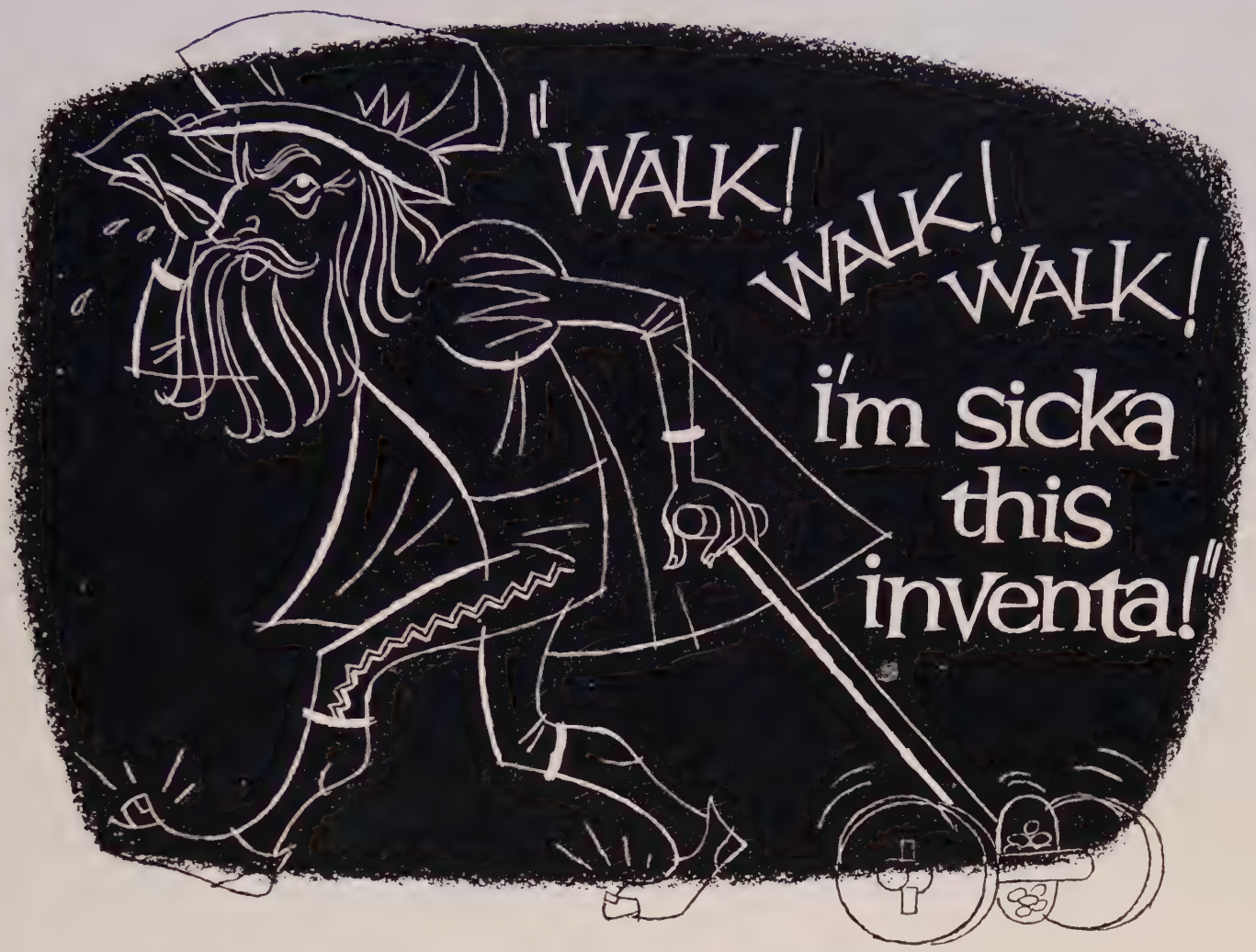
inders must travel through the manifold and cross-over (or cross-under) pipe to join the gases leaving the right bank (or left) of cylinders via the manifold and tailpipe on the right-hand (or left-hand) side of the engine. By the installation of a dual exhaust system, the efficiency of operation is increased due to the fact that each bank of cylinders has its own individual exhaust system, and exhaust gases are carried away independently. With the installation of headers, which will be further discussed later, this technique is carried even further, as each combustion chamber has essentially its own exhaust system independent of the others. It is apparent that by the installation of a dual exhaust system the capacity of the system is doubled, making it possible for the exhaust system to handle a larger volume of exhaust gases in a given time, thereby minimizing back pressure.

When installing an exhaust system to give the best efficiency possible, attention should be paid to the exhaust manifold construction. The internal roughness of cast iron and the sharp angled design of conventional manifolds resist the smooth flow of exhaust gases, and the heat is not dissipated as the exhaust gases leave the cylinders.

By replacing this conventional manifold with a streamlined "header" system, constructed either of cast iron, cast steel, or tubular steel, which permits a smooth flow of exhaust gases to leave the engine, there is a decided improvement in the rate at which the exhaust gases are taken from the engine. This results in faster heat dissipation (cooler running engine), increased efficiency, greater horsepower, and more fuel economy. The V-8 engine lends itself particularly well to the header and dual exhaust system due to the divided cylinder construction (two banks of cylinders). But on the bad side of the case for headers is the fact that they usually add to the vibration noise in the car. This is alleviated somewhat by the use of cast iron headers which absorb much of the noise.

Different sources show different amounts of increase in horsepower due to a dual exhaust system. This variance is due to different makes and different conditions and equipment in the same models. For such a system without headers, tests on the road and on dynamometers show a horsepower increase from 7 per cent to 15 per cent. With dual exhaust header systems the horsepower increase goes up to 30 per cent in some cases. Back pressure is decreased around 70 per cent in both cases. Obtained from several sources, these figures agree with those from the two well-known automotive engineering firms—Almquist Engineering Co., Inc. and Newhouse Automotive Industries. [3-4] Roger Huntington,



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Each time the wheels turned, a bean dropped to a container below the axle. Then Leonardo counted the beans and multiplied by the wheel circumference to learn how far he'd walked.

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of the Society of Automotive Engineers (SAE), states in his book on increasing engine performance that a dual exhaust header system will add at least 10 horsepower to the engine.[5]

One interesting thing to be noted in connection with a dual exhaust header system, with or without straight-through mufflers, is that there is a continuous increase in horsepower with increase in miles per hour of the automobile. With the standard one-muffler car, a maximum in horsepower is reached at a speed of approximately 75 to 80 miles per hour. This is, of course, variable with the cars used. As higher speeds are obtained, the horsepower then decreases with this system. This means there is more labor for the engine when one is driving at high speeds with a standard exhaust system.

The total cost of a header dual exhaust system runs in the neighborhood of $50, with the headers costing approximately $30 and the exhaust system about $20. The latter is composed of two mufflers, exhaust pipe, tail pipe, and fittings.

In conclusion, the case for a dual exhaust system can be summarized as the following. A dual exhaust system provides:

1. Increased gas mileage.
2. Increased maximum speed.
3. Faster acceleration.
4. Faster heat dissipation.
5. Cooler running engine.
6. Better idling.
7. Smoother running engine.
8. Greater horsepower.
9. Less labor on the engine.
10. Increased engine efficiency.

[1]"How to Hop Up Your Chevvy, Ford, or Plymouth," *How To-Magazine,* XIII (Fall, 1954), 4-7.

[2]"Don't Exhaust Your Dollars," *Economy Driving, A Car Life Annual,* No. 101 (1955), 52.

[3]*Almquist Engineering Power Catalog* No. 500 (1954), 4-5.

[4]*Newhouse Automotive Industries Speed Power Economy Catalog* No. 258 (1954), 40-43.

[5]Roger Huntington, *How to "Hop Up" Ford and Mercury V8 Engines.* Los Angeles: Floyd Clymer, 1951. pp. 104-105.

Jet Engine Lubricant

A new silicone lubricant with outstanding thermal and load bearing properties is being vigorously tested.

The silicone fluid has satisfactorily passed thermal stability and viscometric tests ranging from —65 degrees F to 500 degrees F. Steel-to-steel bearing load tests have shown the fluid to have excellent lubricating qualities up to 107,000 pounds per square inch bearing area.

Present commercial silicone oils are well known for their high degree of thermal stability combined with a favorable viscosity-temperature relationship. These oils also possess desirable properties such as high flash temperature and low pour and freezing temperatures. In spite of this array of good qualities, however, they have always been poor lubricants for ferrous metal surfaces under boundary lubricating conditions where the film of lubricant between surfaces approaches the thickness of two or three layers of molecules.

The new lubricating silicone fluid was developed by Dr. Gordon C. Gainer, who supervises chemical department activities of the Westinghouse Materials Engineering Department.

"The problem of developing good lubricating properties for steel versus steel," Dr. Gainer said, "was approached through the modification of the silicone oil molecule." It was assumed that the conventional silicone molecule is not absorbed strongly enough on the steel surfaces to form a close-packed film or protecting layer or layers. As a result metal to metal contact is not prevented on parts that continually rub together. Research studies were thus concentrated on the alteration of the silicone oil molecule to produce a material capable of forcing a surface chemical reaction at the metal oil boundary.

The new lubricant has been tested under the most severe laboratory induced conditions. One such device is the Shell Four-Ball testing machine. Here a steel ball is rotated while held against three steel balls. The entire Four-Ball assembly is immersed in a container filled with the fluid to be tested. While one ball is turned at a constant speed, the other three stationary balls can be accurately pressed against the rotating steel ball, the system acting as a finely controlled "nut-cracker." Metal to metal pressures can be built up until the parts actually "seize" or weld in the terminology of lubrication engineers. It is in this piece of testing equipment that bearing pressures of 107,000 pounds per square inch have been attained. Presently available jet engine lubricants will cause "seizure" of the metal parts between 14,000 to 27,000 pounds per square inch bearing area.

"The new lubricant has also been tested in a Westinghouse turbojet engine," Dr. Gainer said. At the completion of this test, the engine was completely torn down and examined. No evidence of wear was found by engineers and the system was entirely free of any sludge derived from the new lubricating silicone oil.

This type of lubricant is being manufactured by Dow Corning Corporation of Midland, Michigan. The latter company is now supplying the lubricant to the military services for further testing.

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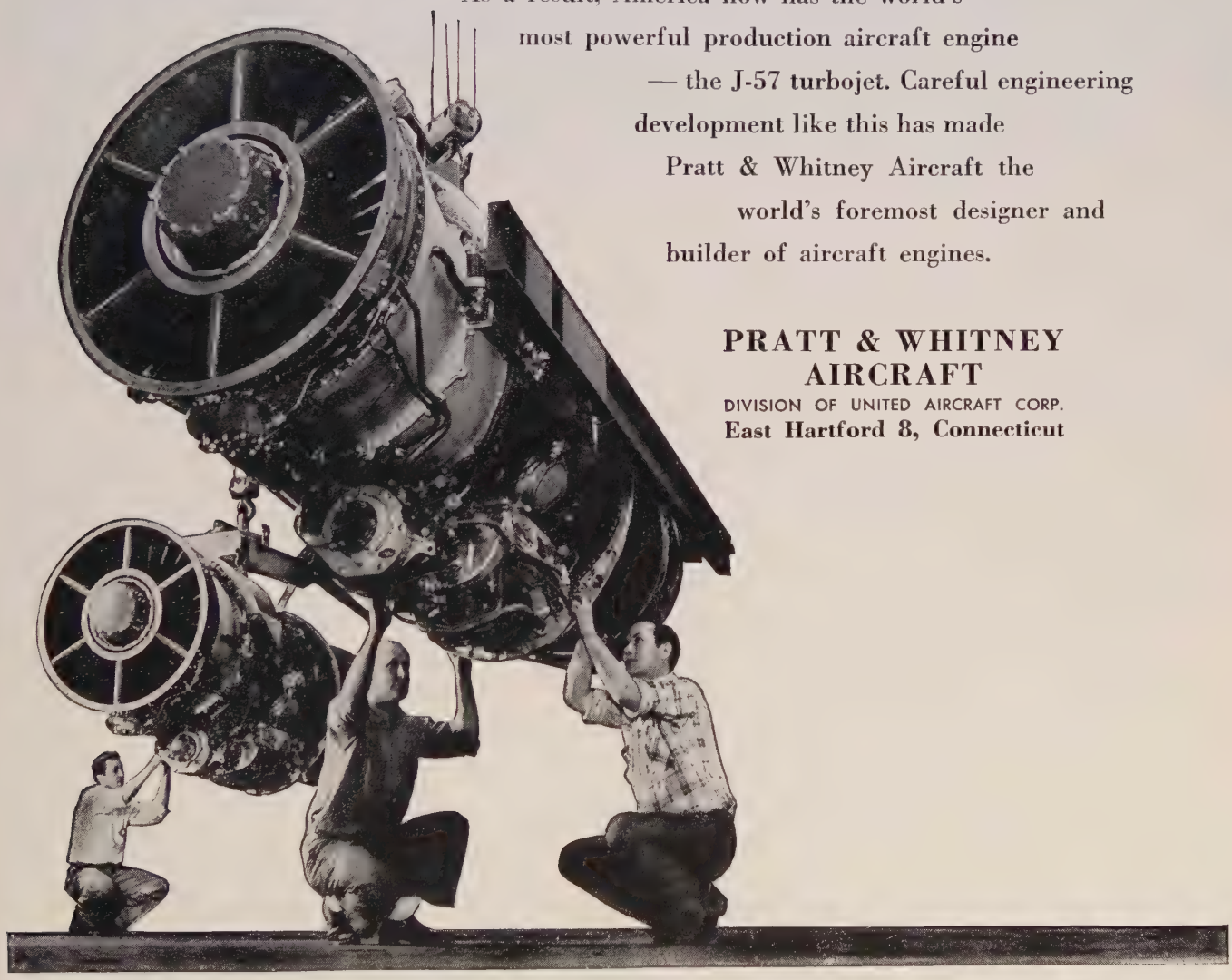
. . . 4,000,000 individual, complex mathematical problems solved by electronic computers.

As a result, America now has the world's most powerful production aircraft engine — the J-57 turbojet. Careful engineering development like this has made Pratt & Whitney Aircraft the world's foremost designer and builder of aircraft engines.



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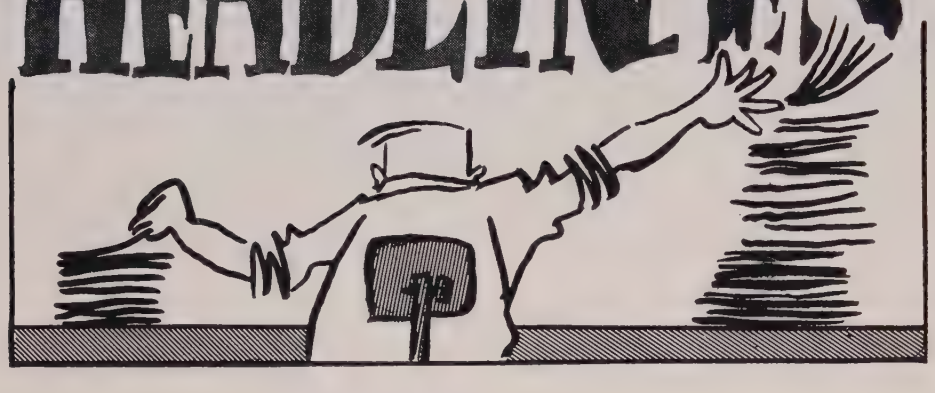


by Larry Kiefling, M. E. '56

Instruments First

Fledgling pilots may learn to fly by looking at instruments before they learn by watching the ground—completely the reverse of usual procedures—if the newest idea being tested at the University of Illinois works out.

While they will not become instrument pilots, they will be able to handle themselves in an emergency when sight of the ground is blotted out. The project is being carried out by the Institute of Aviation and the Aviation Psychology Laboratory at Illinois under a grant from The Link Foundation.

Instrument instruction is being included in training for a private pilot license being given 18 students including one co-ed. Results of the project are expected in July.

The purpose, says Prof. Alex C. Williams Jr., head of the Aviation Psychology Laboratory, is "to demonstrate whether it is possible to give basic instrument and contact training so that in the same amount of flight time a student will be able both to pass the private pilot test and have some knowledge and proficiency in instrument flying."

If successful, this may become a part of the Illinois Flight Plan, developed at the University of Illinois several years ago which—without increasing their training flight time—gives students training and experience in use of an aircraft as well as knowing how to get the plane safely off the ground and back down again.

That plan utilized an open-cockpit Link trainer known as the "School Link." In it are the basic instruments of every aircraft—oil and fuel gages, engine speed indicator, altimeter, turn indicators, and compass—plus the gyro compass and the artificial horizon.

Pilots who know how to use these can keep their craft level without sight of ground, and in time of trouble turn back, come down, go above the overcast, or as a final resort, fly through.

The project has been named "COIN" —Contact-Instrument System of Flight Instruction. Prof. Williams explains that the idea of teaching both instrument and contact flying simultaneously has been discussed for 20 years, but only recently has it been proved that there is a much larger transference of training from instrument flying to contact flying than by the reverse.

Friction Testing Machine

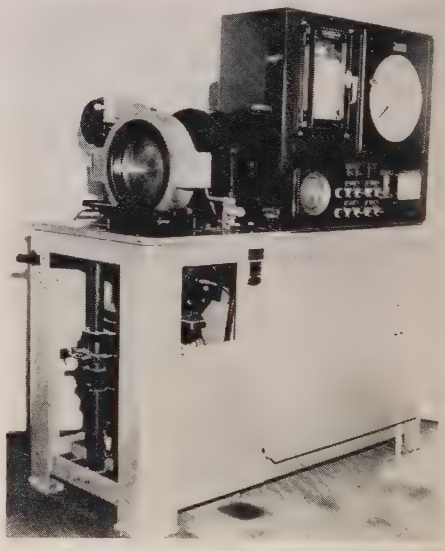
The design and development of a new machine for friction testing of materials under load, such as brake linings, that embodies several new concepts in testing and machine design has been announced.

The design of the machine is based on the fact that if a loaded sample of the material to be tested is held and made to ride on the rim of a revolving drum, at a point on the vertical center line, a horizontal friction force tangent to the drum surface will result.

Because this horizontal frictional force is approximately the same at all speeds, a variable speed-constant torque power unit must be used to power the drum through all speeds and loading conditions desirable to test the material. The revolving drum is mounted on the end of a shaft that is mounted in self-aligning ball bearings. Between these bearings is a flywheel driven by two 'V' belts. Maximum full speed of the shaft is a little more than 900 R.P.M.

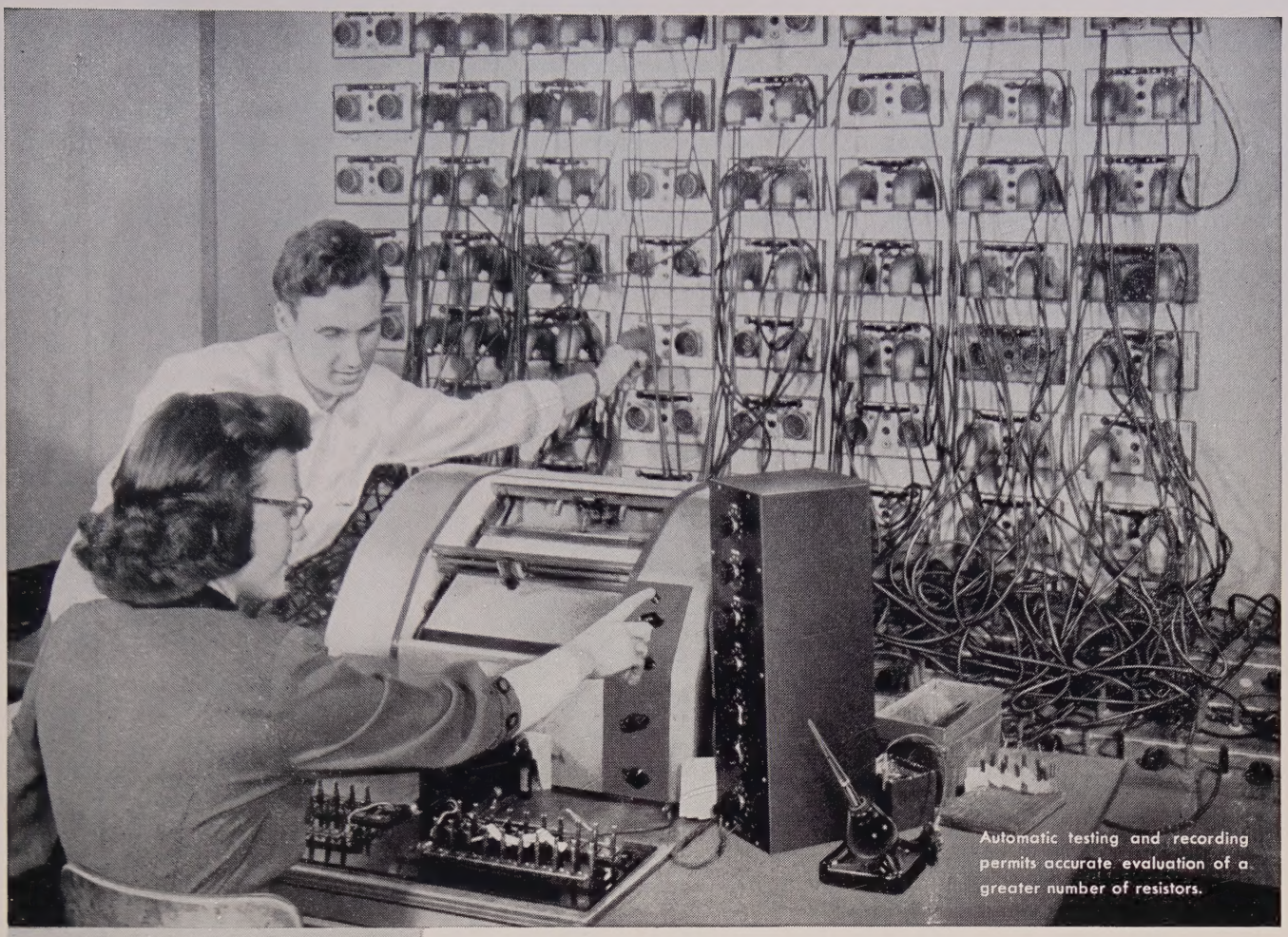
One of the important features of the new machine is a restraining device that has the ability to maintain position of the test sample on the vertical centerline of the drum regardless of any variation of the frictional force. This restraining device, pressure sensitive, measures and makes a continuous record of the characteristics of the material when subjected to any desired condition of operation.

Another important feature of this new method of applying load and transmitting friction force to a measuring device, is that the position of the loading unit is entirely controlled in the friction force line of action by the recording unit itself. The loading unit is kept within the plane of rotation of the force by two small ball end links which are perpendicular to the line of force. This arrangement insures that there are no losses to be considered that would affect the recorded friction force.



Pressures up to 200 lbs. can be exerted against surfaces by this friction testing machine.

In operation a test sample one-inch square is held in a specially designed block which is hinged at the center of the test piece in the revolving drum's plane; this hinged block insures uniform



Automatic testing and recording permits accurate evaluation of a greater number of resistors.

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MIL-R-26B Specification

Type BW Low Wattage Wire Wounds
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transverse distribution of pressure and also permits regular examination of the test sample and easy replacement.

Samples under test can be loaded in 25 pound increments up to 200 pounds. For cycling the application and release of the load an air cylinder with a solenoid-operated air valve is provided. Control of the cycling is handled electrically and is adjustable from intervals of ten seconds up to two minutes.

Since the heat resulting from the work done by such a small test piece of friction material is not always sufficient to raise the temperature of the drum to that comparable in brake service, electric heating elements with a capacity sufficient to raise the drum temperature well above most friction materials' critical temperatures have been installed in a housing surrounding the drum. Thermocouples are installed in the drum and lining with current collector rings made of thermocouple materials on the drum hub to provide for indication of the operating temperatures of drum and lining. Records of these temperatures are kept automatically.

Metal Bellows, Device of 1,000 Uses

The metal bellows, an invention that ranks with the rivet and the gear as a useful industrial device, has just begun its second half century in American industry.

For half a century, metal bellows have proved themselves versatile performers in hundreds of different ways. They are found in office buildings, railroad cars, diesel engines, the family auto, in newest jet aircraft and atom plants throughout the country. In heavy industry they control the flow of liquids at just the right temperatures. In contrast, they are found in greenhouses guarding the growth of delicate plants.

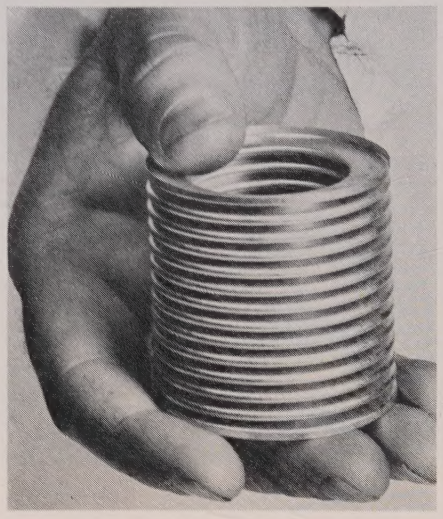
Made from many different metals, bellows are precision-made cylinders whose thin walls have been deeply pleated similar to those of an accordion or folding camera. Once the metal tubes have been corrugated and formed into bellows, they can be expanded and contracted within limits governed by the number of corrugations used. For various uses, bellows are made in diameters ranging from a fraction of an inch to 12" and larger.

Bellows were invented by a Knoxville (Tenn.) weatherman named Weston M. Fulton who was seeking a simple way to measure atmospheric pressure. A local plumber gave him the idea of applying his invention to the development of an automatic damper for steam boilers used in home heating.

The first metal bellows was a soldered brass affair. Undependable at best, the soldered seams would burst under any great stress. Young Fulton experimented with devices for drawing tubes from flat sheets of sterling. Designing intricate dies, Fulton perfected a method of producing seamless metal bellows that were durable and inexpensive to manufacture.

More useful today than ever before, metal bellows are finding new important places in this jet and nuclear fission age. They are being used for oxygen regulators in high altitude aircraft. In these aircraft, bellows assure correct fuel and air mixtures by counteracting changing air pressures. As integral parts of many bombsights, metal bellows help bombardiers lay their explosives "on target."

Bellows assemblies, many fabricated from special steel alloys, are used in regulators and as the packless feature of



Small metal bellows used in oxygen regulating apparatus because of its sensitivity to pressure.

valves at the Oak Ridge atom plants.

First designed as automatic damper regulators for household furnaces, they are now used to make home appliances more automatic, easier to build, and easier to operate; and they've given added safety and efficiency to hundreds of types of machines, buildings and carriers.

At the Knoxville plant, metal bellows are turned out in a smooth and uninterrupted flow from metal stock that is received in strips or coils of specified physical characteristics. In one automatic operation, circles of metal are punched out and formed into deep cups. The cup then goes through a series of drawing and annealing operations, establishing the diameter and wall thickness of the tube. The tube is then trimmed to correct size.

Most bellows under 4⅜ inches outside diameter are formed hydraulically; larger units are formed mechanically with roll dies. To produce the former, the tube is placed in a hydraulic machine and pressure is applied inside the tube, forcing it to take the shape of the corrugated die. The inside diameter of the hydraulically formed bellows is substantially the same as that of the tube and, conseguently, "cold-work" is imparted chiefly to the outer bends.

The other process used to make bellows, consists of forming a number of broad corrugations in the tube wall and successively deepening and narrowing these broad corrugations with suitable rolls. The diameter of the tube used making the rolled bellows is less than the outside and greater than the inside diameter of the finished bellows. "Cold-work" is, therefore, imparted to both inner and outer bends, resulting in bellows that have elastic characteristics especially suited for many applications.

The final number of uses for metallic bellows will probably never be determined. So varied are its properties that even veteran bellows experts avoid hazarding a guess. But their usefulness continues to grow as each year hundreds of new commercial applications for bellows are found.

DENTAL SERVICE

An unusual plan in free plant medical examinations is a dental clinic at a Long Island aircraft plant where student dental hygienists from a local college give professional tooth cleaning plus free dental advice. In addition to cleaning teeth, the student technicians examine them for cavities and, where treatment is indicated, refer employees to their family dentists. It's good practice for the trainees, free dental service for the workers and smart employee relations fo rthe company, the magazine points out.

* * *

MAGNETOSTRICTION

The fact that nickel changes in length when it is magnetized has brought about a growing industrial application of the principles of magnetistriction. This property of nickel is applied in high-frequency industrial cutting tools, burglar alarms, sonic depth-finding equipment and submarine detection apparatus and related devices for locating schools of fish.

* * *

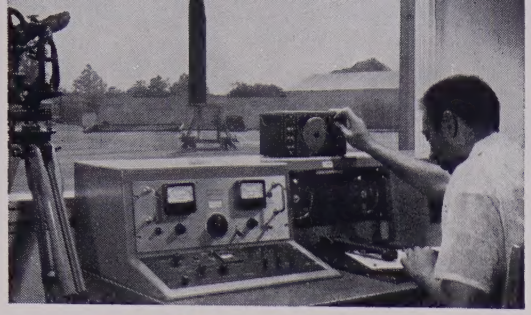
PSYCHOLOGY TO THE RESCUE

Psychologists for the National Advisory Committee for Aeronautics had an important role in solving some very tricky problems that had the group's mathematicians stumped. Statistical techniques used by psychologists are able to handle problems that usual mathematics can't touch.

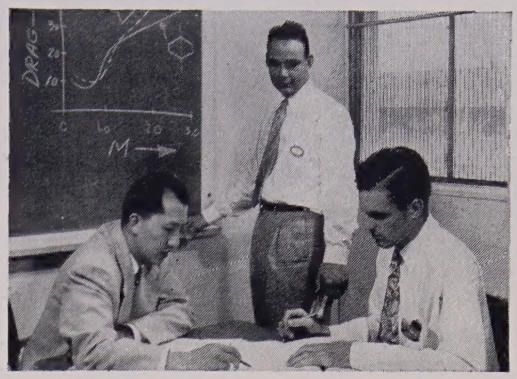
* * *

MECHANICAL MATH

A $135,000 electronic digital computer, recently installed at one oil company's research center, will handle a problem in about 15 minutes which ordinarily would take an experienced refinery engineer about two weeks to solve.



Electronics Research Engineer Irving Aine records radiation antenna patterns on Lockheed's Radar Range. Twenty-two foot plastic tower in background minimizes ground reflections, approximates free space. Pattern integrator, high gain amplifier, square root amplifier and logarithmic amplifier shown in picture are of Lockheed design.



Jim Hong, Aerodynamics Division head, discusses results of high speed wind tunnel research on drag of straight and delta wing plan forms with Richard Heppe, Aerodynamics Department head (standing), and Aerodynamicist Ronald Richmond (seated right). In addition to its own tunnel, Lockheed is one of the principal shareholders in the Southern California Cooperative Wind Tunnel. It is now being modified for operation at supersonic Mach numbers.

Research Engineer Russell Lowe measures dynamic strain applied by Lockheed's 500,000 lb. Force Fatigue Machine on test specimen of integrally-stiffened Super Constellation skin. The Fatigue Machine gives Structures Department engineers a significant advantage in simulating effect of flight loads on a structure. Among other Lockheed structures facilities are the only shimmy tower in private industry and largest drop test tower in the nation.

C. H. Fish, design engineer assigned to Lockheed's Icing Research Tunnel, measures impingement limits of ice on C-130 wing section. The tunnel has a temperature range of −40°F. to +150°F. and maximum speed of more than 270 mph. It is the only icing research tunnel in private industry.

Advanced facilities speed Lockheed engineering progress

Lockheed's unmatched research and production facilities help make possible *diversified* activities in virtually all phases of aviation, military and commercial.

They enable engineers to test advanced ideas which would remain only a conversation topic in firms lacking Lockheed's facilities. They help give designers full rein to their imagination. They make better planes — and better careers.

Engineering students interested in more information on Lockheed's advanced facilities are invited to write E. W. Des Lauriers, Lockheed Student Information Service, Burbank, California.

Lockheed

AIRCRAFT CORPORATION

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Technocracks

Scene: A lonely corner on a dark night.

A voice :Would the gentleman be so kind as to assist a poor hungry fellow who is out of work? Besides this revolver, I haven't a thing in the world."

* * *

A CE approached a cigar counter and said, "I usually smoke that brand in the can."

"And that's the best place to smoke them," replied the sweet young thing behind the counter.

* * *

Little Audrey nailed the bathroom door shut and then laughed and laughed, because she knew her big brother and his college friends were having a beer party that night.

* * *

First Dog: "Do you have a family tree?"

Second Dog: "No, we're not particular."

* * *

Dean of Women: "Are you writing that letter to a man, Miss Bagle?"

Miss B.: "It's to a former roommate of mine."

D.O.W.: "Answer my question."

"Did you get home from the party all right last night?"

"Fine, thanks, except that as I was turning into my street some idiot stepped on my fingers."

* * *

As he felt his way around the lamp post, the overloaded engineer muttered, "S'no use, I'm walled in."

* * *

"I knew them danged scientists would keep a-foolin' around until they did something they hadn't oughter," stormed the old man of the hills. "Now look what they've gone and did."

"What's that, Pa," asked his wife, "you mean the atom bomb?"

"Heck no," exploded the old man, "they've discovered something besides likker to cure a cold."

* * *

"Is it a modern farm house?"

"No. Five rooms and a path."

* * *

ENGINEER'S LAMENT

Somehow it seems I cannot think,
Until I've had a little drink.
And when I've had a little drink,
Somehow it seems I canot think.

He: Do you like nuts?

She: Are you proposing?

* * *

First Communist: "Nice weather we're having."

Second Communist: "Yeah, but the rich are having it too!

* * *

Breathes there a man so far abnormal
He can't be stirred by a low-cut formal.

* * *

Mrs. Bunk was going to visit her husband's relatives on H Street.

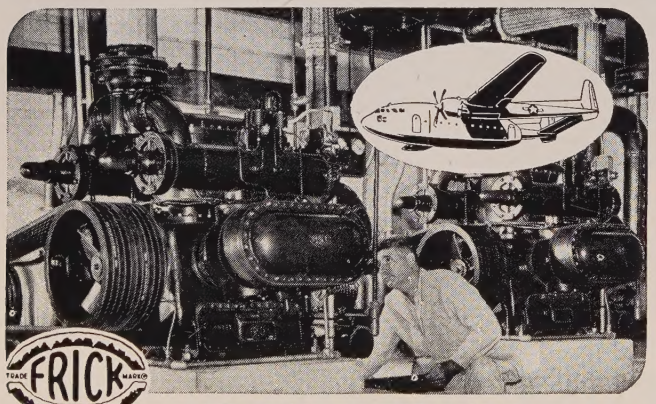
She forgot the number so she wired him from the depot. "Where shall I go to?"

He wired back: "773H."

Mrs. Bunk read it upside down and now she's suing for a divorce.

CHANGE OF COVER

Due to technical difficulties, the originally scheduled cover described on the contents page could not appear. Instead is shown Lincoln hall, one of the busiest class buildings on campus. It houses, among other offices, those of the College of Liberal Arts and Sciences and several of its departments. Two museums and a theatre also are located in this building.



AIR CONDITIONING

Frick Company recently completed the engineering and installation of a year 'round comfort air conditioning system for the new office annex of the Fairchild Aircraft plant in Hagerstown, Md., where they manufacture their famous C-119 Flying Boxcars.

The cooling load of 245 tons of refrigeration is carried by two Frick "ECLIPSE" 9-cylinder high-speed compressors.

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